National Aeronautics and Space Administration

2010 ANNUAL REPORT






NASA Earth Science
Applied Sciences Program

Letter from the Director

Lawrence Friedl, Director, Applied Sciences Program

Welcome to the NASA Applied Sciences Program's 2010 Annual Report. Each year the Program funds activities for organizations to discover and demonstrate innovative and practical benefits of Earth observations. 2010 was a noteworthy year. This report captures some of the Program's achievements and highlights projects using Earth observations to enhance decision making. The report also provides a review of programmatic changes instituted this year.

As we look back on 2010, the Applied Sciences Program was involved in events that made international headlines. Projects we previously invested in had big payoffs. For example, NOAA and European aviation officials used NASA's *Aura* satellite observations of volcanic ash to develop aviation advisories and expedite the opening of European airspace following the Iceland Eyjafjallajökull volcanic eruption. Program partners used NASA *Terra*, *Aqua*, and *EO-1* satellite observations to support mapping and disaster response for flooding in Pakistan. Officials used observations from *CALIPSO*, *Aqua*, Japan's *ALOS*, and other satellites to track oil from the Deepwater Horizon oil spill in the Gulf of Mexico.

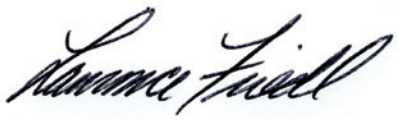
Other efforts may not have garnered headline news, yet they provided important advances in applying Earth science for societal benefit. For example, the National Park Service applied the NASA TOPS model to track the health of ecosystems around park lands and support land management decisions; USAID and NASA opened SERVIR's new hub in the Hindu Kush-Himalayan region; the California Department of Health applied *Aqua* satellite and TOPS model products to improve risk assessment of mosquito-borne encephalitis viruses, including West Nile Virus; and, a United Nations organization launched an international fire-reporting system based on NASA satellite observations.

We made significant changes in 2010 to the Program's focus and structure, seeking to further increase the value for the nation's investments in NASA Applied Sciences. Primarily, we made a difficult decision to concentrate on fewer applications themes. We also developed a two-stage selection process to identify high-reward projects, revamped our performance measures, initiated impact analyses, and engaged the applications community in satellite mission planning. And, yes, there's more ... but you'll have to read the report.

We appreciate the project leaders and their teams for their energy in developing Earth science applications and for their commitment to enabling public and private organizations to use Earth observations effectively.

We want to highlight Michael Goodman, who was on a temporary assignment in 2010 to the Program from NASA Marshall Space Flight Center. He served as the Disasters Program Manager, and he was incredibly effective in a period with numerous, high-profile disasters. We are extremely appreciative of his service to the Program, Earth Science Division, Science Mission Directorate and NASA overall.

As we look ahead, we are excited about the many opportunities we see to enable the use of Earth observations in serving the nation. To learn more about the Applied Sciences Program, please visit: *http://AppliedSciences.NASA.gov*. ●

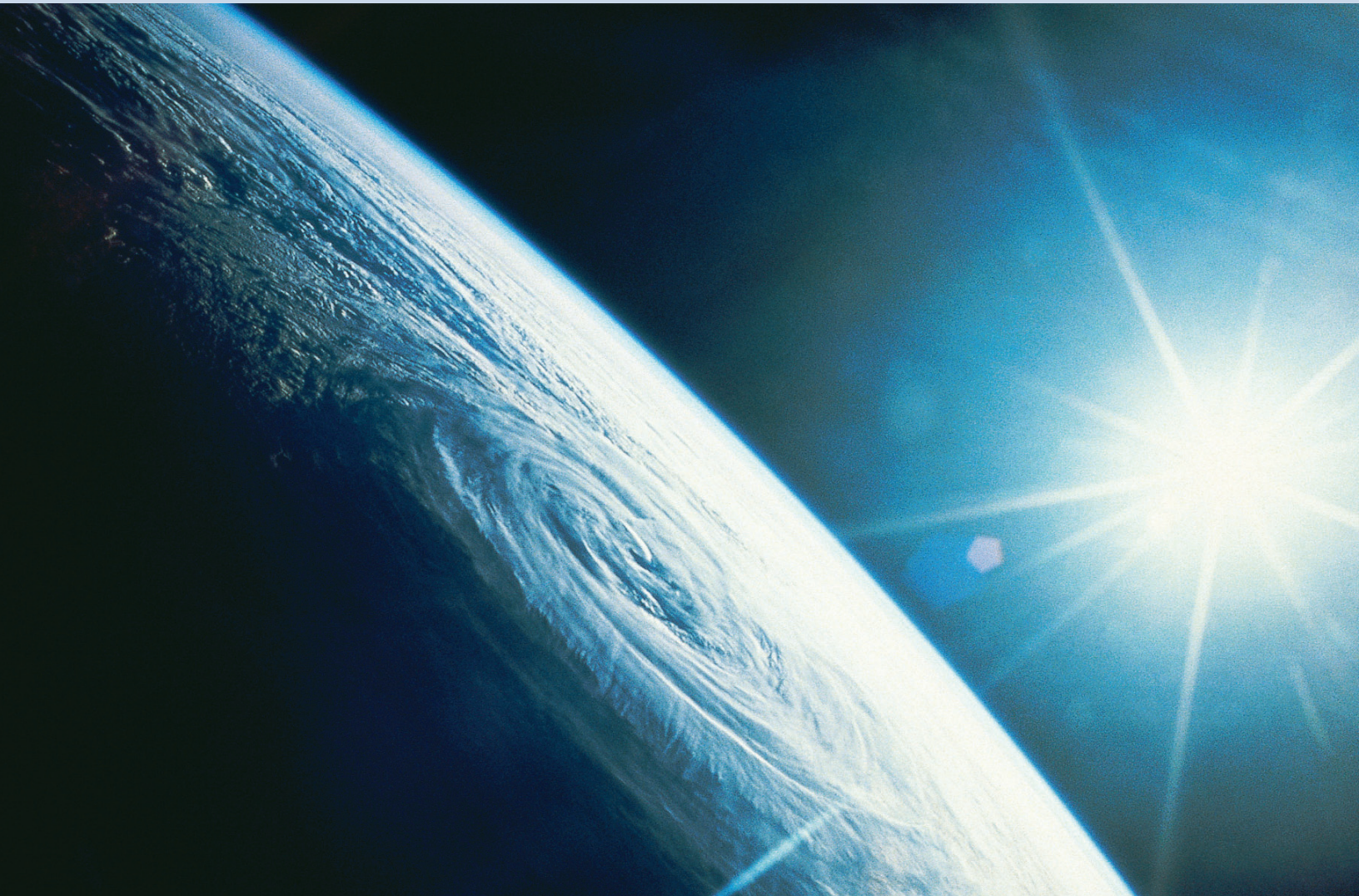


The Applied Sciences Program is part of the Earth Science Division of the NASA Science Mission Directorate.

"NASA's science mission begins here on Earth, with greater awareness and understanding of our changing planet and solutions for protecting our environment, resources and human lives."

Charles F. Bolden, Jr.

NASA Administrator



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“Remote sensing data has become a core part of the planning and evaluation process for organizations like ours — not just environmental organizations but those involved in providing humanitarian services and crisis response.”

John Musinsky

Conservation International

FEATURED PROJECTS AND PARTNERS

The Applied Sciences Program supports efforts to discover and demonstrate innovative and practical uses of NASA Earth science and satellite observations. Stories in the following section highlight projects and Program partners applying Earth observations in ways that enhance the quality of life and strengthen the economy.

Detecting Oil During the Gulf of Mexico Oil Spill

An Applied Sciences project that began in 2008 helped jump start efforts to track the location of oil in the Gulf of Mexico.

When the Deepwater Horizon explosion occurred in the Gulf of Mexico on April 20, 2010, a NASA project monitoring oil spills was already in place. Six months before the platform exploded and sank, an Applied Sciences-funded applications project had already begun testing the use of remote sensing data to locate oil spills in the Gulf.

Sonia Gallegos, an Oceanographer with the Naval Research Laboratory (NRL) at Stennis Space Center (SSC), led the Applied Sciences' project team. Gallegos, who has been interested in automated detection of oil spills for 15 years, said the Applied Sciences funding provided a unique opportunity to create and test oil detection methods.

"With more than 3,800 platforms in the Gulf of Mexico, I thought that one day an oil spill might happen. I wanted to test the ability to monitor those spills by Earth observing satellites," Gallegos said.

The sheer size of the Gulf of Mexico has historically forced federal agencies to rely on chance sightings of oil spills. To improve monitoring efforts, Gallegos wanted to develop automated and interactive techniques to produce oil slick maps at different resolutions, across both space and time.

In 2008, Gallegos and a team of co-investigators submitted a proposal to use NASA Earth observing data to aid in the detection of oil slicks. By early 2010, the team was testing a variety of methods for detecting oil spills. Developing this innovative application of remote sensing data involved the collaboration of researchers from NRL, NASA Langley Research Center (LaRC), and the National Oceanic and Atmospheric Administration's Center for Satellite Applications and Research (NOAA/STAR). This team pooled their collective expertise to develop techniques and algorithms to improve and semi-automate the detection of oil at the surface of the ocean.

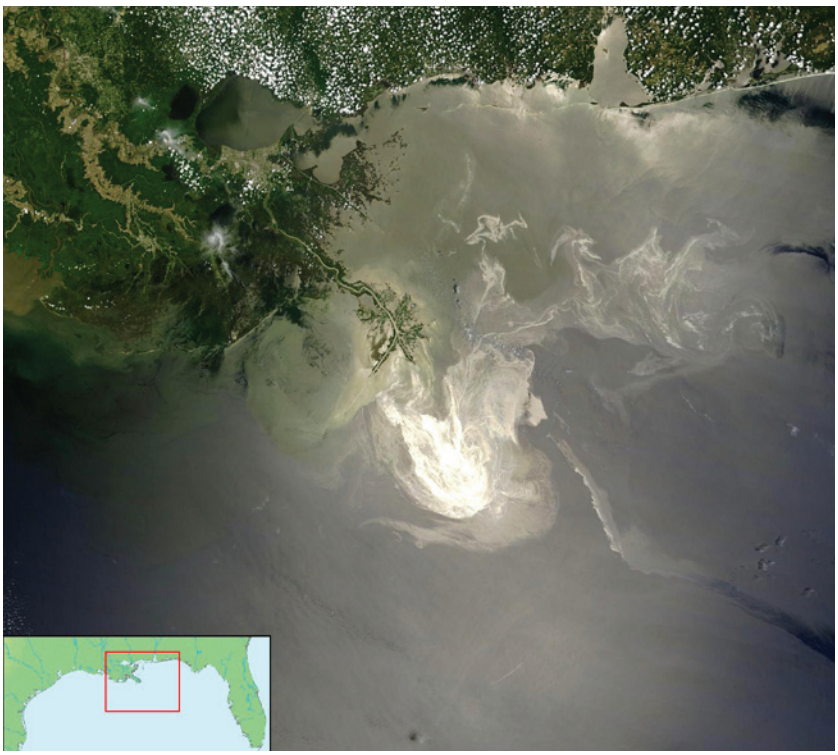
Gallegos' team collected data from the *CALIPSO* satellite and the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor, which is on the *Terra* and *Aqua* satellites. These satellites fly one after the other in the A-Train, a constellation of satellites – including *Aqua*, *CloudSat*, *CALIPSO*, *Aura* and other satellites – that orbit in formation and close proximity. These satellites provide information on the Earth's atmosphere, oceans, and land surface across a broad range of wavelengths.

In the Gulf project, this data was complemented with active microwave Synthetic Aperture Radar (SAR) data from several foreign satellites, including the European Space Agency's (ESA) *Envisat* and *ERS-2*, Canada's *RADARSAT*, and Japan's *ALOS* satellites. Additional data from *Landsat* helped address spills closer to land.

During the Gulf spill response, NOAA was the lead agency monitoring spill activities. NOAA members of Gallegos' team actively participated in SAR data processing and analysis used in identifying the extent of the oil spill in the Gulf of Mexico.

The Gulf oil spill also provided unparalleled opportunities for leveraging resources and sharing data between the investigators in the Applied Sciences project and other agencies and universities. The team shared ship time with the United States Geological Survey (USGS) to collect oil samples and photographs of the oil spill at different stages and places during response efforts. The team also worked with university researchers to jointly analyze oil-contaminated samples and identify phytoplankton collected in areas impacted by the spill. Additionally the team worked with university researchers who were investigating oil thickness and the effect of the Corexit, an oil dispersant.

Moving forward, the team will select the best detection techniques and transition the project to NOAA/STAR for evaluation and implementation. These automated detection procedures will enhance the activities of NOAA's Emergency Response Division, which provides maps for emergency response activities, such as observer's flights, cleanup activities, and installation of booms to protect fragile environments. ●



NASA's *Terra* satellite captures an image of oil in the Gulf of Mexico on May 24, 2010. Sunlight illuminates the lingering oil slick off the Mississippi Delta.

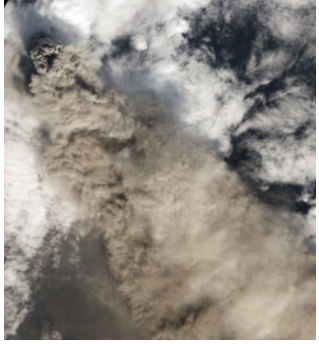
"With more than 3,800 platforms in the Gulf of Mexico, I thought that one day an oil spill might happen. I wanted to test the ability to monitor those spills by Earth observing satellites."

Sonia Gallegos

Oceanographer

Naval Research Laboratory

Tracking Volcanic Ash from Iceland



When ash from a volcano in Iceland closed airports and threatened the safety of international travel, Applied Sciences projects and partnerships provided critical information on the location and trajectory of the ash plume.

Scientists detected seismic activity below Iceland's Eyjafjallajökull volcano in late 2009 and through early winter and spring of 2010. When the volcano finally blew through the glacier's top crater on April 14, 2010, the massive explosion released volcanic plumes into the jet stream, sending clouds of fine dust across mainland Europe and the British Isles.

Because of risks ash posed to aircraft engines, thousands of flights were cancelled, and passengers were left stranded.

As airlines called for more information to assess threats and ensure safety, NASA received requests through NOAA and the Federal Aviation Administration (FAA) to provide customized reports to the Volcanic Ash Advisory Center (VAAC) in London. For the VAAC, NASA built tailored products using data from the Ozone Monitoring Instrument (OMI) on *Aura*, MODIS on *Terra* and *Aqua*, MISR on *Terra* and *CALIPSO*. This event was the first time NASA directly assisted a non-U.S. VAAC. Partnerships that Applied Sciences' projects had developed over years enabled this collaboration and expedited NASA and U.S. support.

"OMI, in particular, has a unique ability to not only monitor ozone but also sulfur dioxide (SO_2), which is a main component of volcanic ash affluent," said John Haynes, Applied Sciences Program Manager for Weather Applications. "OMI SO_2 data provide an accurate proxy for monitoring volcanic ash."

"OMI's data on SO_2 concentrations was inspected regularly throughout the eruption as a further check on the activity of Eyjafjallajökull and the likely position and extent of the main volcanic plume," said Pete Francis, Satellite Applications Manager at the United Kingdom's Meteorological Office.

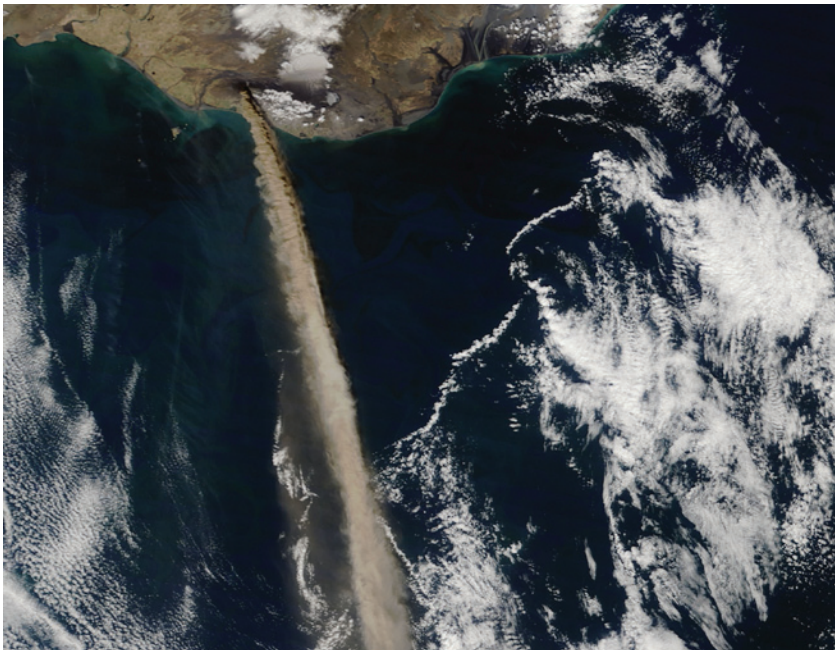
During the volcanic eruptions in Iceland, data from MISR, *CALIPSO*, and Europe's *MSG* satellite were used to validate data from the Meteorological Office's own products. The VAAC also used NASA MODIS and NOAA's Advanced Very High Resolution Radiometer (AVHRR) data to validate and complement data provided from other space agencies that were helping to track the ash cloud as it moved over Europe.

NASA's investment in volcanic ash research and its longstanding partnership with NOAA provided the framework for developing products such as those used to track ash from Iceland's volcanic eruption. NOAA continues receiving updates on volcanic ash and sulfur dioxide plumes from Applied Sciences-funded projects at the University of Maryland–Baltimore County (UMBC) and the University of Wisconsin. This partnership provided critical information to the VAAC during the height of the shutdown of European air traffic.

"NASA was ready to provide the benefit of its research assets to organizations whose mission it is to issue forecasts and keep the airspace safe," Haynes said.

Over the past few years, observations from several sensors on NASA's fleet of Earth observing satellites were applied to create new tools to aid in volcanic ash hazard warnings for aviation. For example, since 2007, NASA has used data from *Aura* to provide advisory centers in Washington, D.C., and Anchorage, Alaska, with regular regional updates on volcanic ash and sulfur dioxide plumes.

Enhancement of applications research in this area will continue in the next decade. For example, the future *HyspIRI* satellite will improve NASA's ability to monitor solid earth hazards, such as earthquakes and volcanoes, by providing insights into where the Earth is moving and forming and where possible volcanic eruptions may occur. Additionally, observations similar to those from OMI will continue through the launch of the *NPP* satellite in 2011 and its Ozone Mapper Profiler Suite sensor onboard. ●



On May 11, 2010, Iceland's Eyjafjallajökull volcano continued to emit a thick plume of ash. The ash streamed almost directly south, visibly extending at least 530 miles from Eyjafjallajökull. The London VAAC estimated the ash reached altitudes of 14,000 to 17,000 feet. The MODIS sensor aboard NASA's *Terra* satellite captured this natural-color image.

"NASA was ready to provide the benefit of its research assets to organizations whose mission it is to issue forecasts and keep the airspace safe."

John Haynes

Applied Sciences Program Manager for Weather Applications

Harnessing the Renewable Energy of Wind Power

A new application uses remote sensing data to expedite locating productive sites for wind farms in the U.S.

The demand for electricity generated from renewable sources is growing at a fast pace. From 2005 to 2009, the Department of Energy (DoE) says the annual growth in U.S. wind capacity averaged 40 percent. Since 2006, wind generators account for 36 percent of total electric power industry capacity additions. To meet this growth, accurate placement of wind farms is crucial for developers and financiers. However, successful site selection often requires years of research and is often a key obstacle for developing this renewable energy source.

To speed the site selection process, Daran Rife, with the National Center for Atmospheric Research (NCAR), envisioned using remote sensing data to accurately map optimal areas for harnessing wind power. Rife leads an Applied Sciences project that is applying NASA Earth science data to increase the accuracy of wind farm placement.

"For the energy industry, very precise wind resource assessments are crucial since financiers and insurers must determine the long-term profitability of prospective wind farms," Rife said. "Even a small amount of wind speed variability can generate an increase in over $1 million in revenue per year for a typical 250-megawatt wind farm."

The tremendous impact of a small variance emphasizes the need for data accuracy and for faster, more reliable models to help determine a site's energy-generating potential. Rife's project is designing a highly accurate and economical wind assessment model using NASA Earth science capabilities.

The new model incorporates innovative statistical techniques and NASA Earth observation datasets from Mirador – a search tool developed at the Goddard Earth Sciences Data and Information Services Center. Mirador is a critical tool for the project because it provides easy access to satellite images and data.

"Mirador is quite simply one of the best catalog searching and data retrieval tools I have ever used, and I have used many over the past 20 years," Rife said.

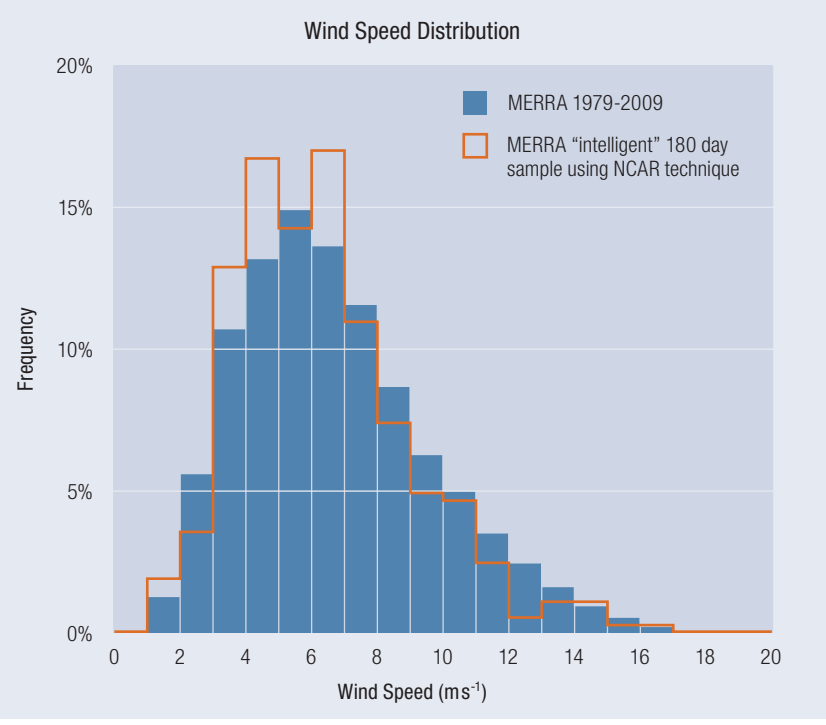
NASA's Modern Era Retrospective-analysis for Research and Applications (MERRA) is another tool used by Rife's project team. MERRA is a three-dimension global record of weather every six hours since 1979. MERRA incorporates a wide variety of surface- and satellite-based measurements, including many important to the development of wind energy applications. With the MERRA data as a starting point, NCAR employs its Climate Four Dimensional Data

Assimilation system, a state-of-the-art weather analysis system that creates high-resolution 3D atmospheric analyses.

Rife's project will allow wind farm developers to incorporate NASA-NCAR analysis into their own decision support systems. Through a commercial partnership with V-bar LLC, a provider of wind energy resource assessments, the project team can now create a 20-year set of analyses to assess regional wind variability across multiple time scales. The project also created the first-ever ability to assess wind variability in any region of the world. The data accounts for influences of local geographic features and other dynamics that affect wind patterns.

The project team continues to refine techniques that will use a sample of days from the complete MERRA dataset to build a 30-year analysis of wind conditions at specific wind farm locations. This dataset is used to estimate the wind energy yield at a prospective wind farm. Initial results indicate that only a 2 to 3 percent sample of the 30-year MERRA record is needed to build an accurate forecast of wind energy. This discovery means that the large cost of creating sub-kilometer weather simulations will be drastically reduced, yet still produce a full wind characterization at a prospective wind farm site.

Looking to the future, Rife's project will evaluate climate regimes in the central Great Plains and along the coast of California – two environments that have great potential for wind-power production. ●



This figure shows two histograms of wind speed distribution. One histogram (blue bars) shows MERRA's 30-year record of daily mean wind speeds at a site in Cabauw, Netherlands. A second histogram (red lines) shows results of the NCAR team's innovative statistical-sampling technique (i.e., a collection of 180 "representative days" from MERRA). The figure shows decent agreement. Frequencies of all wind speed categories differ by less than 2 percent; many less than 1 percent. The agreement indicates that the sampling technique can provide an accurate, reliable, and faster estimate of the wind power production potential at a location. Thus, the technique can significantly reduce the industry's calculations and downscaling expenses, and do so with less uncertainty and risk.

"Precise wind resource assessments are crucial since financiers and insurers must determine the long-term profitability of prospective wind farms. Even a small amount of wind speed variability can generate an increase in over $1 million in revenue per year for a 250-megawatt wind farm."

Daran Rife
Project Scientist
National Center for Atmospheric Research

Monitoring Ecosystems in National Parks

An Applied Sciences project is pioneering the integration of remote sensing data into the National Park Service's park management and decision-making processes. This cutting-edge environmental monitoring helps illustrate changes in park ecosystems and leads to more effective management of park resources.

The National Park Service (NPS) plays a critical role in protecting the biodiversity and rich natural resources in more than 394 areas, covering more than 84 million acres in the United States. However, the health of national parks and protected areas are often dependent on the ecosystems of their surrounding lands. As these neighboring lands become more developed, there is an increased need to monitor the ecosystems around the parks.

To help NPS better understand the connection between national parks and surrounding lands, the Applied Sciences-funded Park AnaLysis and Monitoring Support (PALMS) project monitors and visually depicts the impacts of rapid changes in and around park boundaries.

"Mapping and then managing park-centered ecosystems is critical for maintaining the condition of these parks under land use pressures," said Andrew Hansen, Principal Investigator for the PALMS project. Hansen is a professor of Ecology at Montana State University.

PALMS integrates NASA remote sensing data into the NPS Inventory and Monitoring (I&M) Program that collects, organizes, and makes available natural resource data for analysis, synthesis and modeling.

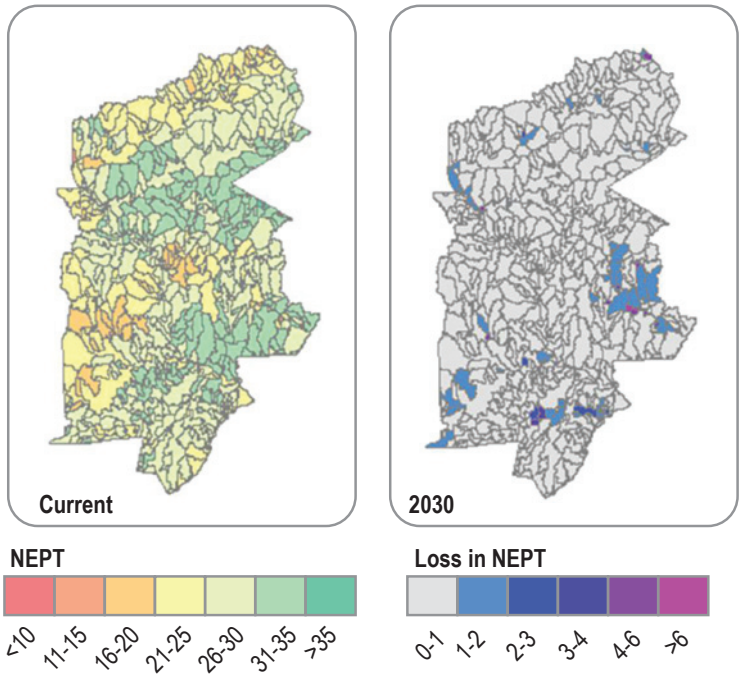
PALMS and I&M teams identified park conditions, or indicators, that remote sensing data would be most effective in monitoring, such as weather and climate, water and streams, land use and land cover. Hansen said that an initial PALMS analysis of climate scenarios produced for Yosemite National Park showed shifts in the timing of snow melt and runoff that reduces summer stream flow and water availability. The projected reduction of water impacts not only Yosemite's wildlife, but also surrounding communities that rely on snow melt for water supplies and agriculture use.

Tom Oliff, NPS Landscape Coordinator at the Greater Northern Landscape Conservation Cooperative, says NASA's data also gives NPS managers a unique opportunity to see their park in a regional context.

"PALMS provides decision support tools that help us understand how to make decisions in individual parks and how those decisions connect to other parts of the surrounding land," Oliff said. "To protect a resource, we may need to partner with a land trust or another federal agency, like the U.S. Forest Service (USFS)."

Components of the project were transitioned to NPS in 2010. Since launching, PALMS has delivered 16 indicators of landscape conditions to park resource managers, including innovative approaches for hindcasting and forecasting land use changes.

The tools generate video simulation models that illustrate changes in the park and surrounding lands. Hansen thinks the power of visually illustrating a changing ecosystem can lead to greater cooperation for improvements, such as conservation easements. "The products developed from this applied research help people understand the connection between parks and the land outside," he said.



This map shows the use of the PALMS tool to illustrate the predicted loss of stream diversity in the Upper Delaware River basin. The data tracks the presence of NEPT, a collection of species known to be sensitive to stream pollution and sedimentation, that are often used as indicators of aquatic health and overall ecological health within a watershed. The Delaware River Watershed provides water to over 17 million people, and the Upper Delaware Scenic and Recreational River is part of the NPS National Wild and Scenic Rivers System.

"PALMS provides decision support tools that help us understand how to make decisions in individual parks and how those decisions connect to other parts of the surrounding land."

Tom Oliff

NPS Landscape Coordinator

Greater Northern Landscape Conservation Cooperative

New SERVIR Hub in the Himalayas

The Applied Sciences' SERVIR program launched a new hub to support the developing countries of the Hindu Kush-Himalayan region. This third hub, SERVIR-Himalaya, integrates Earth observations and forecast models to support environmental management, disaster response, and public health.

The heavy monsoons that inundated Pakistan's Indus River basin in late 2010 left one-fifth of this developing nation under water. Some of the hardest hit areas were also the most remote. In response, the Applied Sciences' SERVIR program provided real-time data to a team tracking the water levels. The newly launched SERVIR hub in the Himalayas provided vital data showing that floods threatened nearly 200 tuberculosis clinics. Armed with this crucial information, aid agencies directed patients to alternate healthcare facilities.

SERVIR provides regional visualization and monitoring services via three operational facilities – SERVIR-Mesoamerica, SERVIR-East Africa, and the new SERVIR-Himalaya. SERVIR has a Coordination Office at NASA Marshall Space Flight Center (MSFC) in Huntsville, Alabama. SERVIR is a joint effort of NASA and USAID.

Assisting aid workers in Pakistan was one of the first major applications activities of the new hub, and it is an example of information SERVIR provides to decision makers in developing countries. The new hub improves environmental decision-making in the Hindu Kush-Himalayan region through dissemination and analysis of Earth observation information. SERVIR-Himalaya draws heavily on MODIS and *Landsat* for work in its priority project topics, including biodiversity, cryosphere, fire detection, disaster preparedness, and air quality monitoring.

SERVIR-Himalaya was launched in conjunction with the international symposium "Benefiting from Earth Observation: Bridging the Data Gap for Adaptation to Climate Change in the Hindu Kush-Himalayan Region." The symposium was held at the International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu, Nepal. More than 50 stakeholders from member countries participated in technical discussions to fine-tune SERVIR-Himalaya applications and to begin customizing them to provide decision support in priority areas.

Inaugural year activities focused on assessing needs of the region which has vastly varying spatial characteristics. These factors influence the social and ecological aspects of mountain development. After being selected as the host for SERVIR-Himalaya, ICIMOD held workshops for government officials in Thimpu, Bhutan, and in Dhaka, Bangladesh. The workshops highlighted a "Decision-Support Toolbox" for ecosystem and natural resource management.

As a follow-on activity to SERVIR-Himalaya's analysis of the devastating 2010 floods in Pakistan, a needs assessment workshop in Islamabad identified gaps and needs for information products. The workshop began building stakeholder capacity for applications development in priority areas.

In 2011, SERVIR-Himalaya will begin building priority applications based on the regional needs assessments. SERVIR will continue working with its network of partners and stakeholders in regional member countries of Afghanistan, Bangladesh, Bhutan, China, India, Nepal, and Pakistan to improve the process of acquiring, analyzing, disseminating, and applying geospatial information and Earth observations in their communities.

To access more information on SERVIR, use this QR code with your camera-enabled smart phone or visit the website below.

http://servirglobal.net

"The SERVIR technology, and our partnership with various organizations and people around the globe, reflects NASA's commitment to improving life on our home planet for all people."

Charles F. Bolden, Jr.

NASA Administrator

Partner Profile: Conservation International

Remote sensing has become an important tool for conservation management, particularly for tracking fires, illegal logging and mining, and deforestation in some of the planet's most isolated regions.

Forests provide countless services to people — filtering fresh water, preventing erosion and landslides, providing a buffer from powerful storms, capturing and holding harmful carbon emissions, and supporting livelihoods and the biodiversity that underpins all healthy economies. Conservation International (CI) is an innovator in using remote sensing data in the development of near-real-time environmental monitoring and early-warning systems that help protect the Earth's biodiversity.

"NASA data has been critical to monitoring the environment," says John Musinsky, Senior Director for CI's Global Change and Ecosystem Services. "It tells us where trends are going for things like fragmented forests and threatened or endangered species. It's a core metric for how we are doing our work."

Thanks to CI's early work, remote sensing data is now a cornerstone in monitoring progress toward conservation targets related to ecosystems services — the goods and services that nature provides to people — and endangered species.

CI first began mapping areas of deforestation in 1999 while working with the University of Maryland (UMD) Web Fire Mapper. CI extended the capability of the Web Fire Mapper to include an email-based system for delivering email alerts with image attachments to subscribers interested in fires occurring within particular protected areas. UMD eventually partnered with NASA to develop Fire Information for Resource Management System (FIRMS), an automated fire-detection system based on daily satellite observations obtained by MODIS.

Today, CI uses NASA data to create alerts provided to numerous conservation groups across the globe. Flora & Fauna International uses CI alerts for near-real-time monitoring of illegal logging and encroachment in national parks in Indonesia and to patrol against poaching of the endangered Sumatran tiger and rhino. Other conservation groups use the data to track changes in land cover and forest loss.

CI currently applies data from a variety of NASA satellites and sensors. *TRMM*, *Landsat* and MODIS data forecast fire risk and study the vulnerability of wetlands to climate and land-use changes. *Landsat* and *Terra* ASTER data are further harnessed as part of an Illegal Logging and Encroachment Monitoring System that is helping park managers and forest patrols detect and apprehend illegal loggers in remote forest areas. CI is looking for ways to incorporate data from the *Jason-1* and *Jason-2/OSTM* satellites to track impacts from sea level rise on coastal wetlands.

Musinsky points to the global and consistent coverage provided by NASA data that allows CI to make science-based decisions on deploying resources, monitoring the effectiveness of current programs, and building capacity in developing countries.

"The satellite observations and data from NASA are among the most important resources we have, and they are critical to our work," Musinsky said. "NASA's near-real-time data enables quick responses and is the basis for the proactive measures we take." ●

Partner Profile: Centers for Disease Control and Prevention

Since 2004, the Centers for Disease Control and Prevention (CDC) and NASA have partnered to accelerate the application of remote sensing data into new areas of public health.

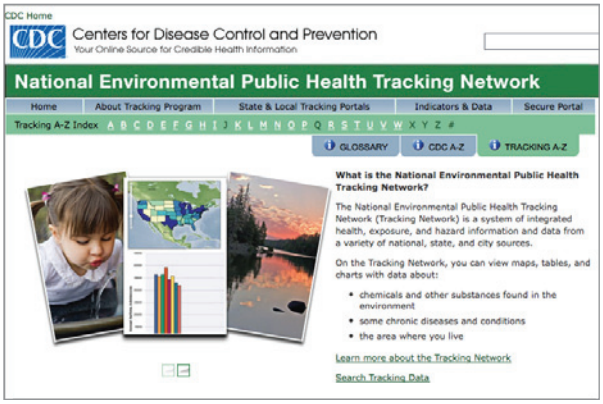
Working together, the two agencies link environmental and health observations to enhance public health surveillance through the Environmental Public Health Tracking Network (EPHTN). EPHTN uses products from the North American Land Data Assimilation System and Earth observation satellites.

In 2010, scientists at the CDC developed a new Climate Change module for EPHTN. The module will initially use remote sensing data from 2000 – 2008 to characterize extreme heat events in the United States. Reviewing past data helps identify unusual trends and develop indicators for extreme heat events. Knowing when these events occur helps communities prepare for a possible increase in heat-related illnesses, and it allows public health officials to alert individuals who might be adversely affected by extreme heat.

"As we learn more about the relationship between climate and health, we can better advise specific groups to take action, particularly when their area may be having a heat wave," said Judith Qualters, Acting Director, CDC Division of Environmental Hazards and Health Effects. "It may be possible for local public health officials to issue heat advisories to vulnerable people in their communities or take other protective actions. The NASA data helps us better understand what impact heat has on health."

The Climate Change module will be available in the fall of 2011 at *www.cdc.gov/ephtracking*. It will provide the public, policy makers, and public health professionals a central resource for climate change-related health and environmental information.

"The NASA partnership has been very valuable for the Tracking Network. Without these data we would not have been able to provide tools and evaluations of heat and heat-related mortality at a national level," Qualters said. ●



The EPHTN is a system of integrated health, exposure, and hazard information and data from a variety of national, state, and city sources. NASA Earth observations data is now a part of the Network, providing data to public health professionals and policy makers across the country.

To access more information on the CDC's EPHTN, use this QR code with your camera-enabled smart phone or visit the website listed above.

Forecasting River Temperatures to Protect Endangered Species

An innovative application of Earth observations has dramatically increased the data available to water managers as they make decisions that help protect endangered or threatened species.

Water managers make decisions every day that balance the short- and long-term needs of urban communities, wildlife, agriculture, hydroelectric power production, and other uses. To develop effective water planning strategies, managers need up-to-date and accurate information on a variety of environmental conditions.

In the Central Valley of California, high demand for limited supplies of water often result in altered in-stream flows and water temperatures. For some fish, such as endangered salmonid species, water temperature is a key indicator of habitat quality. Temperature measurements at frequent intervals help to ensure that water management decisions do not jeopardize endangered or threatened species, as required by the Endangered Species Act.

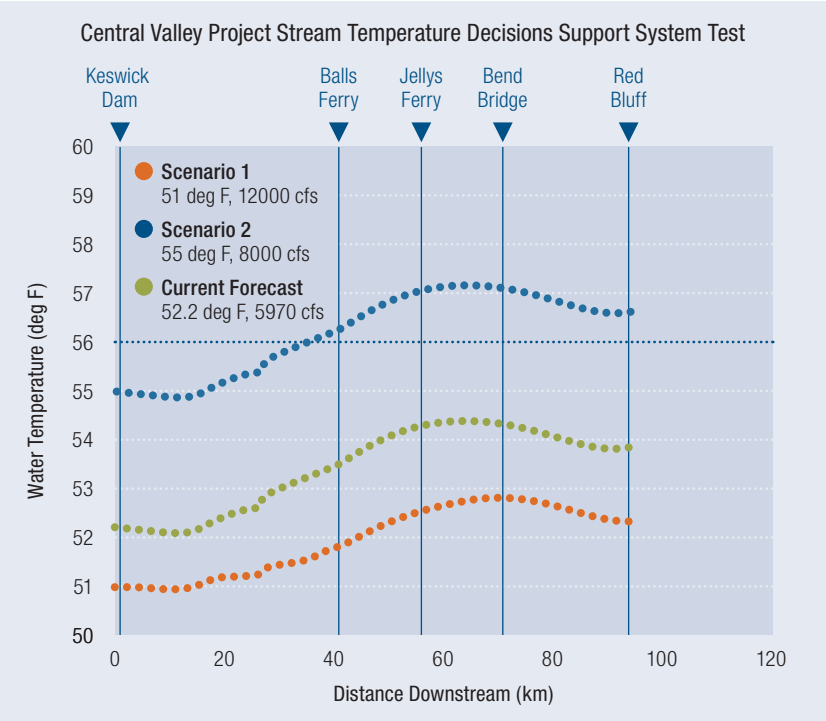
An Applied Sciences-funded project is now providing timely temperature data to water managers through the use of remote sensing data. Before the project, water managers in the Central Valley were using monthly average temperatures at a few places along a river. These data did not account for fine-scale temperature changes that are critical to the continued existence of some endangered or threatened species.

Through a joint project with NOAA, water managers can now receive temperature readings every 15 minutes for essentially all points along the river and can forecast temperatures up to 72 hours in advance.

The team, led by Eric Danner, applied the NASA Terrestrial Observation and Prediction System (TOPS) developed at NASA Ames Research Center (ARC) to integrate satellite observations with NASA and NOAA ecological and physical models to predict river temperatures in California in real time with high accuracy. The team used data from the MODIS sensor onboard the *Terra* and *Aqua* satellites to drive the modeling framework.

“This project has fairly large ramifications for urban and rural water use and on salmon production,” said Danner, who works at NOAA’s Marine Fisheries Service (NMFS). “We needed the NASA data to make this happen and are very thankful to have this quality input. This model shows finer-scale temperature fluctuations that were not possible to model before.”

The River Temperature Forecasting Project is an example of a successful collaboration between the NMFS Southwest Fisheries Science



River temperature forecasts are available via the NOAA PaCOOS web-based data interface and decision support system. This data shows temperatures at different places downstream of dams. With this interface, users obtain forecasts up to 72 hours in advance for use in management of water releases to minimize potential impacts to fish species.

Center and the ARC Ecological Forecasting Lab. Data from NASA and NOAA satellites are integrated into the ecosystem and weather forecasting models, thereby creating data that is fed into the river temperature and fish mortality models developed by NMFS and the U.S. Bureau of Reclamation (USBR). TOPS produces the required inputs for these models, which were not previously available to NMFS.

NMFS fisheries managers can use the data on a daily basis to monitor river temperatures and water volume released into the Sacramento River.

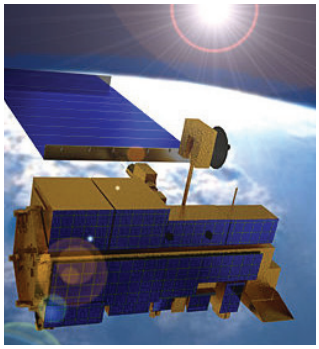
"This model provides the most data and information on any of our fish species in the Central Valley — it's a model for the other species," said Bruce Oppenheim, NMFS fishery biologist. "It gives us data on exactly what is happening to the fish in the river. It tells us how long they're being exposed to temperatures that are too high and what that temperature exposure is."

In 2010, an independent panel of the California Department of Commerce and the California Department of Interior recommended that water managers implement the model. During summer 2011, the model will run alongside the current system for a trial period. Present (nowcasts) and future (forecasts) conditions from the integrated system will be distributed to fisheries managers via the NOAA Pacific Coast Ocean Observing System (PaCOOS), a web-based data decision support system. After this trial run, the model will operate in an official capacity in 2012.

The Exploratorium in San Francisco has included the model as part of a larger exhibit on salmon and the environment. "The steam temperature model provides a highly visual exhibit of the interaction of the biological and physical environments," Danner said. "It's a great way to illustrate the relationship between natural and human-made phenomena." ●

The 2008 collapse of California's largest salmon run resulted in the closure of a salmon fishery, causing an economic loss of $255 million and the loss of more than 2,000 jobs.

Partner Profile: UN Food and Agriculture Organization



Delivering the locations of active fires and hotspots to natural resource managers and firefighters in some of the world's remote areas is now possible through a partnership between Applied Sciences and the United Nations Food and Agriculture Organization.

Developing countries are often susceptible to the damaging impacts of fire because they lack coordinated fire response or have limited resources to fight fires in remote areas. In the past, natural resource managers in these countries struggled to access timely satellite information on fires to improve response time and resource management. With the Global Fire Information Management System (GFIMS), users anywhere in the world can now access fire information in near-real-time from a laptop or mobile device.

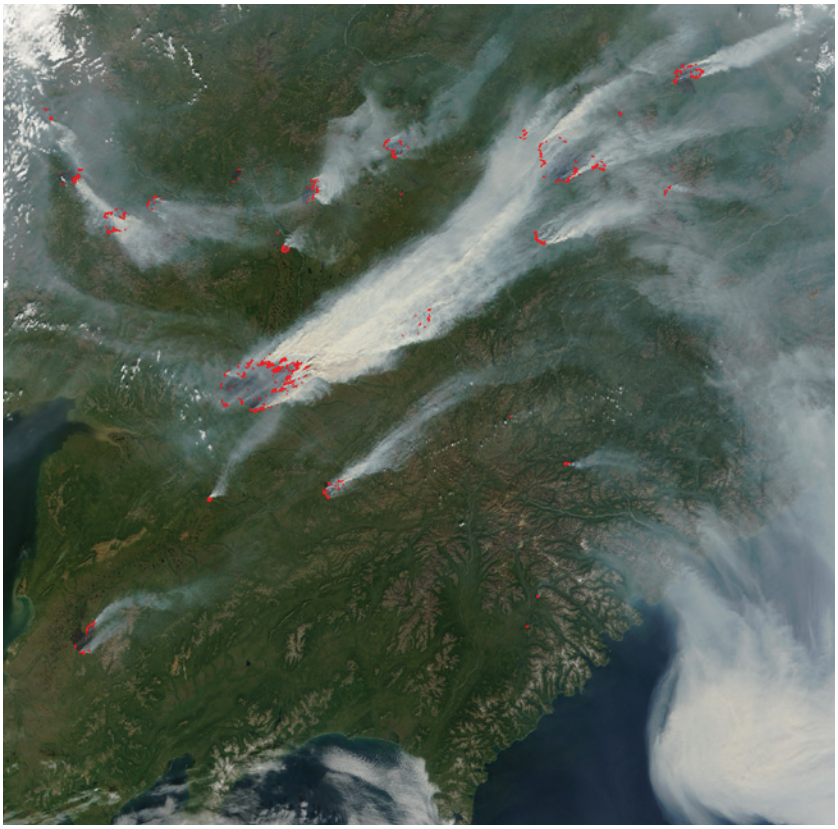
"Natural resource managers were challenged by fragmented information gathered from various sources, making it unsuitable for precise analysis and identifying trends," said John Latham, Senior Environment Officer at the UN Food and Agriculture Organization (UN FAO). "GFIMS is an integrated fire information system that delivers the essential data to its users while the fires are still burning."

Launched in August 2010, GFIMS delivers fire data from imaging sensors aboard NASA's *Terra* and *Aqua* satellites to generate daily fire maps and images through a freely accessible web interface. The system also dispatches detailed e-mail alerts on the quantity and coordinates of fires less than three hours after a satellite passes over burning land. This creative delivery puts information in the hands of local emergency response teams, allowing them to more quickly respond to fires and hot spots.

GFIMS allows users to download fire information in minimal file sizes and in easy-to-use formats, including text files, ESRI shapefiles, Web Map Services, Google Earth/ KML files, and a plug-in for NASA World Wind.

GFIMS successfully transitioned from a NASA Applied Sciences project to a system monitored and hosted at the FAO's Natural Resources Management and Environment Department. The FAO has added country-specific reports and analyses to tailor GFIMS for the broader UN user community. It plans to implement a mobile phone Short Messaging Service (SMS), allowing users to receive fire alerts on mobile phones. GFIMS information is available in English, French, and Spanish.

The Applied Sciences Program is a long-time supporter of the development of fire monitoring systems around the world. The foundation of GFIMS began in 2006, when scientists at the University of Maryland–College Park began developing the FIRMS system with funding from Applied Sciences. FIRMS was significant because it demonstrated large volumes of satellite data captured from various systems and in various formats that could be quickly converted into user-friendly resources. GFIMS built on FIRMS' capability to capture and index global fire information in near-real-time and now provides crucial information to users around the world. ●



Fires raged in eastern Siberia in late July 2010, sending a plume of thick smoke hundreds of kilometers wide over the Bering Sea. News sources attributed fires in the Russian Federation to drought, heat, and human activity. MODIS, on NASA's *Terra* satellite, captured this natural-color image on July 25, 2010. Red dots indicate areas with unusually high surface temperatures usually associated with actively burning fires.

At the height of the 2010 Russian wildfires, 850 fires were burning and smoke stretched across nearly 2,000 miles of Russia. UN FAO, through a partnership with Applied Sciences and the University of Maryland, used observations from *Terra* and *Aqua* satellites to provide daily fire updates to natural resource managers on the ground.

To access more information on GFIMS and learn how to become a user, use this QR code with your camera-enabled smart phone or visit the website below.

http://www.fao.org/nr/gfims/en/

Mapping Carbon Flux in Oregon Forests

A unique application of Earth observations data helps Oregon forest managers understand the carbon flux of more than 30,000 acres across the state.

Forests play a vital role in the carbon cycle through the absorption of carbon dioxide from the atmosphere and, subsequently, the mitigation of carbon-related climate change. The U.S. Forest Service estimates that American forests store enough carbon to offset about 16 percent of U.S. fossil fuel emissions. However, not all forests solely remove carbon dioxide. Some release carbon through events such as wildfires, insect infestations, and timber harvests. This dichotomy complicates forest management strategies that incorporate carbon absorption through the cycle of forest growth, death and regeneration.

To help forest managers understand carbon flux, Mark E. Harmon, professor of Forest Science at Oregon State University, developed a unique model that uses remote sensing data to gain insight into the carbon flux of Oregon's forests.

"Remote sensing data allows us to cover an area in-depth," Harmon said. "We can look at this data and quickly determine if there are changes in the forest cover."

The year-long feasibility study compared high resolution images from *Landsat* and NASA archives to detect changes in the forest cover. The project was complemented by data from the USFS Forest Inventory and Analysis (FIA) program, which gives the team a state-wide view of forests.

Harmon's innovative approach to carbon assessment will be used by the Oregon Roundtable on Sustainable Forests to assess the feasibility of forest management plans. Created by the Oregon Department of Forestry (ODF), the Roundtable promotes forest resource management by integrating environmental, economic and social considerations into the management of Oregon lands.

"Mark's modeling is unique and has illuminated the complexity of carbon storage and dynamics in forest ecosystems," said Andrew Yost, Forest Ecologist with ODF. "We have traditional estimates of carbon flux based on inventory plots, but Mark's data integrates the physiological functions of forest ecosystems with state-of-the-art landscape modeling, satellite remote sensing, large-scale vegetation mapping, and computer simulation. His work uses the technology investments of NASA and puts them into a useful format to help us better understand the annual flux of carbon through Oregon forests."

The NASA Earth observations data also provide strong visuals of changes in forest coverage. These visuals help forest managers and the general public understand changes occurring in their communities.

"It's one thing to give a report or have a graph," Harmon said, "but remote sensing data animates changes over time. People can better understand the changes with these visuals."

Harmon's work will continue into 2011. After an initial analysis of four geographic sections of Oregon, the Roundtable asked Harmon to use remote sensing data to examine the entire state. They found the initial analysis did not include areas impacted by the 2002 Biscuit Fire, which burned almost 500,000 acres in southern Oregon and northern California.

State officials and forest industry representatives requested the inclusion of these areas to create a more accurate, historical view of the state's forests.

"Mark's work uses the technology investments of NASA and puts them into a useful format to help us better understand the annual flux of carbon through Oregon forests."

Andrew Yost

Forest Ecologist

Oregon Department of Forestry

Using Earth Observations to Assess Air Quality

Throughout the year, the Applied Sciences' Training program helps build skills in accessing and using Earth science. These interactive, hands-on sessions are an opportunity for users to become familiar with remote sensing and satellite observations. They help users apply NASA data to a variety of applications areas.

Atmospheric modeler Scott Beaver attended a 2009 class of the "Remote Sensing Data Usage in Air Quality Assessments" as a student. Within a year, Beaver returned to the class again. In 2010, though, he was an instructor, sharing his experience in applying Earth observations to his air quality management work.

"Instructing a class in 2010 gave me the chance to show results from actual applications over central California," Beaver said. "I was able to present recently available satellite-based products to attendees who might face similar needs in their own states."

Beaver works for the Bay Area Air Quality Management District (BAAQMD) and is a staff researcher at the University of California, Davis. The modeling Beaver conducts provides information to BAAQMD air quality planners developing emission reduction programs. Models simulate a variety of regulated pollutants with known adverse health impacts including ozone, fine particulate matter, and air toxics. He attended the program's 2009 Air Quality Assessment class to help develop approaches for evaluating air quality models and assessing central California air quality.

For this purpose, Beaver uses three remote sensing products, including MODIS true color imagery, *CALIPSO* time-altitude aerosol data, and *Aura* OMI tropospheric column trace gas measurements. Combined with surface-based instrumentation, satellite data provide a more complete, three-dimensional description of air quality.

"Satellite data help fill in gaps for the existing surface monitoring networks," Beaver said. "OMI trace gas measurements, for instance, were highly valuable for assessing the model's ability to accurately simulate the regional distribution of important precursors for pollutants. Evaluating the model against remotely sensed data provides additional confidence that simulations are reliable tools for real-world decision support systems."

Modeling results provided valuable information in developing BAAQMD's 2010 Clean Air Plan (CAP). The CAP outlines the district's first-of-its-kind "multi-pollutant" plan which addresses trade-offs in simultaneously reducing precursors of several pollutants. The modeling allowed all emissions types to be weighed on equal footing based on their contributions to levels of pollutants.

Using the simulation results, regulators can study alternative emissions reduction plans, weighing the efficiency and cost effectiveness of regulating various types of emissions that behave differently in the atmosphere. A multi-pollutant approach allows planners to meet regulatory requirements in a manner that maximizes overall public health benefits.

The use of modeling to support air quality planning becomes increasingly important as emissions reductions become more costly and air quality regulations become more stringent. Remotely sensed data, used with existing surface monitoring networks, help ensure that models portray conditions properly and that regulatory decisions are grounded in sound science.

"Remotely sensed data can help other communities develop science-based regulatory strategies for addressing their unique air quality management issues," Beaver said.

"Remotely sensed data can help communities develop science-based regulatory strategies for addressing their unique air quality management issues."

Scott Beaver

Atmospheric Modeler

Bay Area Air Quality Management District

APPLICATIONS AREAS AND CAPACITY BUILDING ACTIVITIES

The Applied Sciences Program promotes the use of satellite observations and NASA Earth science to improve decision-making activities of public and private organizations. In 2010, the Program supported eight Applications areas – Agriculture, Air Quality, Climate, Disasters, Ecological Forecasting, Public Health, Water Resources and Weather.

Applied Sciences supports activities to build capabilities and broaden the range of users applying Earth observations for societal benefits. In 2010, the Program supported four Capacity Building Activities – DEVELOP, SERVIR, Gulf of Mexico Initiative, and Remote Sensing Training.

Applied Sciences also leads tasks and contributes to activities in the international Group on Earth Observations.

Agriculture

The Agriculture Applications area promotes the use of Earth observations to enhance agriculture management and policy making, helping planners adapt to extreme events, such as drought, and impacts of climate change. The Agriculture program focuses on agricultural risk assessment, forecasting, water management, and global food security. In 2010, the program expanded some efforts to global scales, enhancing agriculture models with Earth observations for global food supply analysis.

One project applied MODIS crop characterization information with India's *Resourcesat* data to support the United States Department of Agriculture (USDA) National Agricultural Statistics Service (NASS) efforts to improve food supply estimates in the United States. These estimates are critical for timely response for multi-billion dollar United States government farm programs and commodity markets to food supply anomalies. The use of MODIS data allows crop area estimates to be realized in a more timely and reliable fashion, and it can reduce USDA expenditures for *Resourcesat* data.

A project in partnership with the USFS and UMD applied satellite products to assess North American forest disturbance and regrowth. This project contributed to the establishment of an initiative called the Landscape Change Monitoring System, which provides an institutional framework for *Landsat*-enabled change monitoring. The project supported USFS FIA Program's capacity to produce and analyze satellite disturbance data. Additional mapping resources have been added by training "off-season" field workers in image processing techniques and establishing relationships with third-party contractors.

In 2011, several projects will continue and several will conclude. The Agriculture program expects that USDA's and USAID's global monitoring efforts will be enhanced through improvements of moisture measurements in yield models and more comprehensive identification of agriculture area. The program expects advances in the measurement of food production through improved measurements of crop yield and area, and it expects improved forest-carbon monitoring efforts in support of USFS operations and global policy initiatives.

Air Quality

The Air Quality Applications area promotes uses of Earth observations to enhance air quality management, particularly issues associated with implementation of air quality standards, policy, and regulations for environmental, economic, and human welfare. In 2010, NASA and the U.S. Environmental Protection Agency (EPA) renewed a five-year Memorandum of Understanding, with air quality being a key area of partnership of the agencies.

The *Three-Dimensional Air Quality System* (3DAQS) project, running from 2005-2010, developed quantitative data fusion of satellite and surface observations to support air quality forecast guidance. Over the course of the project, 3DAQS transitioned to an operational system at NOAA. In 2010, the project enhanced EPA's Remote Sensing Information Gateway (RSIG), which is an operational web-based tool (*www.epa.gov/rsig*) enabling users to access a variety of air quality datasets. 3DAQS enabled RSIG to link MODIS and *CALIPSO* observations of aerosols with EPA's ground-based monitoring network, providing a more complete description of time and spatial changes in aerosols.

A project, entitled *Assimilating Aura-derived Trace Gas Retrievals and MODIS AOD into an Operational Multi-pollutant Air Quality Forecast Decision Support System*, evaluated *Aura* OMI NO_2 seasonally-averaged measurements, weekly temporal variations, and other sources such as wildfires. The project created more accurate seasonal inventories for use by the forecast community. Using *CALIPSO* observations, the project also developed a first-generation estimate for haze layer heights to improve forecast guidance to more than 200 broadcast TV clients.

In 2010, the Applications area co-sponsored several conferences and workshops, including EPA's National Air Quality Conference in March, the Global Atmosphere Watch Aerosol Lidar Observation Network (GALION) Workshop in

To view the video series "Science for a Hungry World", use this QR code with your camera-enabled smart phone or visit YouTube at the following website.

http://www.youtube.com/watch?v=1RJ6AqWAOEg

September, and the American Association for Aerosol Research Annual Conference in October.

The Air Quality program also conducted a peer-review evaluation of proposals to the first-ever Air Quality Applied Sciences Team (AQAST). The program will announce the AQAST selections in 2011. This team will pursue key, long-term applied research topics in the air quality community, and apply the latest scientific knowledge to address urgent, short-term needs that states and air quality managers identify.

Climate

The Climate Applications area enables the use of Earth observations in assessments, policy analyses, and organizations' planning and response to climate change. The area includes energy and carbon management topics. In 2010, the *Solar and Wind Energy Resource Assessment* (SWERA) project completed. This project integrated NASA Earth science products into the SWERA tool to improve estimates of global renewable energy potential in the analysis and sizing of renewable energy projects.

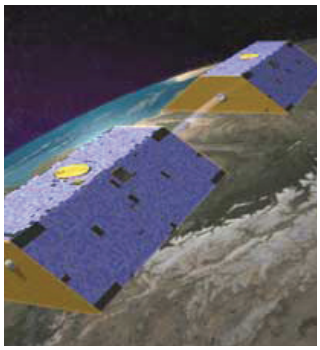
Another project made significant progress in assessing the use of NASA models to improve the accuracy of climate zone maps used in building designs. The project is in partnership with the DoE and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), which establishes efficiency standards and measurement methodologies.

In 2010, the program continued to support activities for GEO, Committee on Earth Observation Satellites (CEOS), and the International Energy Agency (IEA). The program also led Applied Sciences' contributions to the U.S. National Climate Assessment. *Applied Energy* published a paper describing Applied Sciences' six-year collaboration with CEOS member agencies in renewable energy and energy efficiency decision support. *Nature Climate Change* discussed the utility of regionally downscaled climate models to inform climate, health, agriculture, and economic impacts of tighter vehicle-emission standards.

In 2011, a feasibility study will examine the use of Earth observations to improve forest carbon accounting and possible use in carbon trading applications. A project using NASA-derived products to improve accuracy of load forecasts for natural gas and electricity utilities will conclude. Also, an IEA best practices handbook on solar resource standardization will include NASA's contributions.

Disasters

The Disasters Applications area promotes the use of Earth observations in forecasting, mitigation, and response to natural and technological disasters. In 2010, the Disasters program continued to provide satellite observations and applications for national and international disasters. NASA responded to several events, including earthquakes in Haiti and Chile, the Eyjafjallajökull volcanic eruption in Iceland, the Deepwater Horizon oil spill in the Gulf of Mexico, and flooding in Pakistan. Data products from NASA satellite and airborne sensors (e.g., *TRMM*, *EO-1*, ASTER, MODIS, AVIRIS, UAVSAR) were used to identify affected areas and provide operational international, national, and state agencies and non-governmental organizations (NGOs) with information to better enable response and recovery efforts.



The Disasters program coordinated with several interagency and national groups, including the President's National Science and Technology Council's Subcommittee on Disaster Reduction and the National Academy of Sciences' Disasters Roundtable. The program participated in a Disasters Roundtable workshop on "Translating Remotely Sensed Data to Assets, Exposure, Damage, and Losses." The workshop identified ways to improve the flow, understanding, and use of remotely sensed images and data before, during, and after disasters occur.

In 2011, Applied Sciences plans to hire a full-time Program Manager for the Disasters Applications area to direct investments on innovative applications of Earth observations. The Disasters program also expects to complete a formal plan to improve preparations and enable faster response efforts for the Earth Science Division's (ESD) disaster response activities.

Ecological Forecasting

The Ecological Forecasting Applications area promotes the use of Earth observations to assess impacts of environmental change on ecosystems and their components to aid in decision making. Several projects concluded their work and transitioned to operational partners in 2010, including GFIMS (see page 20) and PALMS (see page 12). Also, a marine project transitioned enhancements, including use of Earth observations and ocean model outputs, to an operational system that forecasts stocks and sets harvest quotas for Peruvian anchoveta. This improved system provides end users better tools to forecast fish biomass and distribution during El Niño events.

At the end of 2010, the U.S. Fish and Wildlife Service (FWS) was reviewing the Ecosystem Assessment Geospatial Analysis & Landscape Evaluation System (EAGLES) tool for transition into their operations. EAGLES helps land managers assess the impact of climate change on species, and it assists the FWS with habitat conservation and species protection.

NASA is a co-lead of the GEO Biodiversity Observation Network, which integrates biodiversity data across multiple organizations globally (see page 37). NASA is also co-leading the GEO Model Web initiative, which facilitates interoperability of modeling efforts and increases access to models and their outputs. In partnership with the broader Community on Integrated Environmental Modeling, a pilot project connecting a variety of ecological and physical models is underway.

Several projects will conclude in 2011. A project with NOAA and Department of Defense (DoD) is evaluating geospatial tools modeling the density of whale species in the Atlantic and Pacific Oceans. The project will help define whale habitats and provide greater insights on their movement. The data will help direct ship traffic and provide guidelines for DoD underwater testing that ensure marine mammal safety while providing adequate testing opportunities needed for national security. Also ending in 2011 is a project with USGS using Earth observations and species distribution models to estimate where Africanized honey bees will settle in the Southern United States. New projects planned include developing tools to assess animal migration and its relationship to the climate, and a project integrating systems to help land managers assess land-use vulnerability and their management options in a changing climate.

Public Health

The Public Health Applications area promotes uses of Earth observations for public health and safety, particularly regarding infectious disease, emergency preparedness and response, and environmental health issues. In 2010, collaboration began with the CDC and its Wide-ranging Online Data for Epidemiologic Research (WONDER) system. WONDER makes information resources available to public health policy makers, health care providers and the general public. Linking with the CDC WONDER system will substantially expand public exposure to NASA Earth science data. In other projects, USAID, USDA, the World Health Organization (WHO), the U.S. Coast Guard and DoD applied NASA Earth observations to their health decision-making processes.

A project with the California Department of Health successfully achieved the operational integration of NASA data products (e.g., TOPS model, MODIS, AMSR-E, and *Landsat*) into the California Mosquito-borne Virus Surveillance and Response Plan (CMVSRP). Enhanced products are distributed to CMVSRP users throughout California for improved risk assessment of mosquito-borne encephalitis viruses, including the West Nile Virus. The results of these efforts will be evaluated after 2010 for extension to other states, including Colorado and Washington.

The Public Health program hosted its annual review in September. Project leads and partner organizations presented more than 20 papers at the event. The program also presented papers and posters at the American Public Health Association, American Meteorological Society, American Society of Tropical Medicine and Hygiene, American Thoracic Society, and other public health events.

In 2011, the program will continue its collaboration with organizations to define the impacts of climate change on public health. The program is expecting results from its work on enhancing decision support capabilities concerning avian influenza risks and pandemic early warning. Also, a feasibility study with Columbia University and WHO on meningitis risks in the African Sahel is due to conclude. This project supports a key GEO Health task.

Also in 2011, Applied Sciences will announce the awards for a new set of feasibility studies for public health applications. The program will also pursue joint solicitations with other organizations such as CDC, NOAA and the National Institutes of Health.

Water Resources

The Water Resources Applications area promotes the integration of Earth observations into water resource management for sustainable use of water. In 2010, projects addressed water quality and many sources of water supply – precipitation, snow melt, surface water, and ground water. Working with the California Department of Water Resources, the Water program provided guidance on water issues stemming from snow melt. The water management activities use NASA data to more accurately calculate snow melt, which provides water for citizens, agriculture, and hydroelectric power production across the state. U.S. forces in Afghanistan also used NASA snow melt data to better understand water supply availability.

In 2010, several collaborating federal agencies and the U.S. military deployed water models developed or improved by NASA. During World Water Day on March 22, the UN recognized NASA's innovative technologies that sustain healthy ecosystems and advance water resource management decisions. Throughout the year, the Applications area hosted workshops and presented papers at eight national and international water resource meetings.

In 2011, the Water Resources program will integrate *GRACE* satellite measurements into ground water change models for enhanced water supply estimates and enhanced snow water equivalent estimates in the Western United States and Central Asia. NASA will sponsor community meetings on practical uses of NASA evapotranspiration measurements and water indicators and applications of geodesy in groundwater measurements. The program will expand the use of Land Surface Modeling to more organizations. Applied Sciences will also issue a solicitation for new projects focused on drought and water management.

Weather

The Weather Applications area promotes the use of Earth observations in support of specific weather-affected economic interests that enhance the global mobility of people and material, including aviation and space weather. In 2010, the Weather area continued its active participation in federal and international weather initiatives such as the FAA Volcanic Ash Working Group, the International Civil Aviation Organization's International Volcanic Ash Task Force, and the NOAA Office of the Federal Coordinator for Meteorology. These groups are especially important for sharing volcanic ash expertise and applications developed by the Weather area using NASA MODIS imagery from *Terra* and *Aqua* satellites, *Aura* OMI chemistry data and *CALIPSO* aerosol data.

The Weather program continued its emphasis on convective weather, which produces thunderstorms, high winds, heavy precipitation, hail and lightning, and is a leading cause of weather delays in the National Airspace System. Researchers at NCAR and the University of Wisconsin-Madison Cooperative Institute for Meteorological Satellite Studies (CIMSS) developed a new gridded global turbulence forecast. The forecast is designed to enhance the accuracy and timeliness of World Area Forecast System (WAFS) decision support products including alerts and weather charts. A new Global Graphical Turbulence Guidance product is expected to improve the safety and efficiency of international air travel and reduce the workload of WAFS forecasters.

In 2011, Weather projects will continue focusing on convective weather. With a competitive grant awarded by the Weather program, Massachusetts Institute of Technology's Lincoln Laboratory is collaborating with the University of Alabama in Huntsville and the University of Wisconsin CIMSS to improve convective weather forecasts for aviation. This collaboration has been working toward transitioning NASA's SATellite Convection Analysis and Tracking convective initiation system into the FAA's Corridor Integrated Weather System. The system will lead to considerable improvements in weather forecasting tools for air traffic operations. ●

To hear a podcast on how NASA Earth science helps airplanes avoid storms, turbulence and delays, use this QR code with your camera-enabled smart phone or visit the website below.

http://earthsky.org/human-world/john-murray-nasa-helps-airplanes-avoid-storms-turbulence-delays

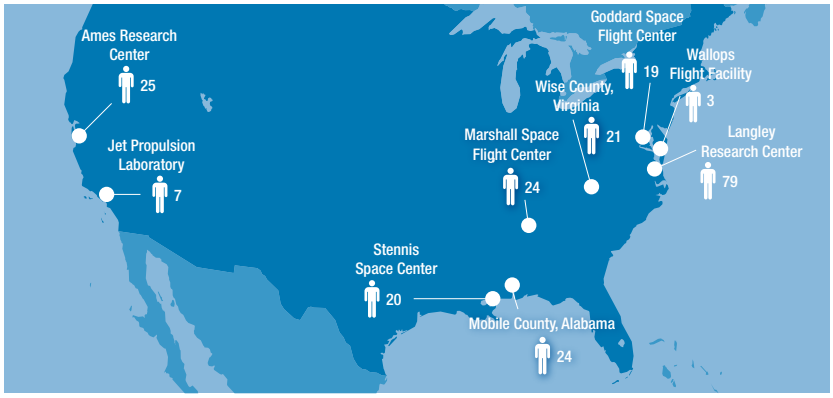
DEVELOP

DEVELOP, a NASA Applied Sciences training and development program, provides students and young professionals experience in utilizing and integrating satellite remote sensing data into real-world applications. Participants gain experience in delivering and communicating scientific results to broad audiences including government, academia, and industry. Through DEVELOP, these young professionals extend the benefits of NASA Earth science and technology to the public.

In 2010, DEVELOP established successful partnerships with the EPA, the North Carolina Division of Coastal Management (NCDCM), and the USFS. The DEVELOP team at SSC partnered with EPA Region 6 to monitor air quality and the impacts on public health during sugarcane and marsh burning. DEVELOP teams at LaRC partnered with NCDCM to leverage Earth observations to assess climate change impacts and enhance decision making related to shoreline loss and coastal change. The NASA Jet Propulsion Laboratory (JPL) team employed NASA Earth observations to monitor changes in the Pacific Ocean temperature, height and current patterns. These observations were correlated with changes in the Pacific Hake population and assisted in improving fishery management practices.

In 2011, DEVELOP students will begin working with NASA's Climate Adaptation Science Investigator working group to examine the impacts of climate change on NASA Centers across the United States. NASA officials will use applied research recommendations in future infrastructure planning and risk mitigation. DEVELOP will also partner with GEO to conduct Earth observation decision support projects in Mexico, addressing the societal benefit areas of Health, Water and Agriculture.

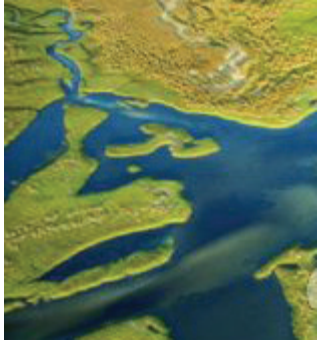
In the next year, DEVELOP expects a record number of applicants for internships and projects. The program will also add a new Young Professionals initiative to foster longer-term projects. DEVELOP's expanding portfolio continues to provide students valuable personal and professional development, as DEVELOP strives to support national needs in innovation.

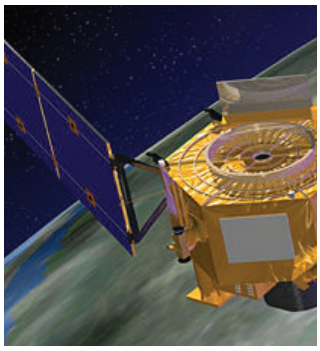


In 2010, DEVELOP awarded more than 200 internships in support of 34 domestic and five international projects. DEVELOP presented at more than 30 international, national, state and regional conferences.

To access more information on DEVELOP, use this QR code with your camera-enabled smart phone or visit the website below.

http://develop.larc.nasa.gov





SERVIR

SERVIR supports capacity building activities that put Earth observations and geospatial information into the hands of environmental managers and decision makers in the developing world. Information provided to decision makers includes web-based access to satellite imagery, decision-support tools, and interactive visualization capabilities. In 2010, there was an increased focus on awareness of the services and functionalities provided by SERVIR.

SERVIR-Mesoamerica sponsored several workshops throughout 2010. "Satellite Monitoring of Guatemalan Priority Water Bodies" strengthened the Guatemalan Ministry of the Environment's capacities to use satellite data to monitor lakes for pollution and algal blooms. Similarly, a workshop on satellite-based forest mapping in Costa Rica provided environmental managers hands-on experience with satellite image processing. Attendees learned how to identify forest cover and use the information to monitor forest carbon and develop greenhouse gas inventories.

In May, the SERVIR-Mesoamerica hub worked with USAID, NASA, and the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC) to host the first "Regional Symposium on Geospatial Technology Applications in the CAFTA-DR Countries" in Panama City, Panama. The event featured national priority pilot projects that use geospatial technology applications for key issues, including tourism, environmental monitoring, forest fires and coastal contamination.

A partnership of the SERVIR-East Africa hub with USGS led to the development of a two-week Rapid Land Cover Mapping training course on time-series analysis of land-use and land-cover change in East Africa. Attendees included 14 land managers from Kenya, Tanzania, Uganda, Rwanda, and Ethiopia who created wall-to-wall land cover maps for their respective countries. They also developed an integrated land cover mapping system that enables information sharing across the region.

In 2011, SERVIR will collaborate with USAID, NASA, and CATHALAC to host the second "Regional Symposium on Applications of Geospatial Technologies for Environmental Management, Response to Extreme Events and Climate Change Adaptation" in the CAFTA-DR countries in Panama. The Symposium will focus on the impacts of SERVIR in CAFTA-DR countries since SERVIR's inception in 2004.

Gulf of Mexico Initiative

NASA Applied Sciences formed the Gulf of Mexico Initiative (GOMI) in 2007 to help states in the region recover from the devastation of Hurricanes Katrina and Rita. GOMI leverages the nation's investment in NASA Earth observations to create tools and information that help local, state and federal leaders make informed decisions, establish policies, and respond to crises. In 2010, the Gulf Initiative involved 48 projects with a total value of approximately $19 million. Nationwide, hundreds of applied scientists and engineers worked to address high priority issues identified by the states bordering the Gulf of Mexico.

During the 2010 Gulf oil spill, many projects funded by GOMI proved vital as states scrambled for data to establish the condition of coastal ecosystems before they were affected by oil or dispersant. Many GOMI researchers were also on the front line of the crisis, using multiple NASA satellites and airborne instruments to gather ecological data, monitor vital ecosystems, and to spot and track the oil slick.

SSC managed GOMI-distributed information about NASA remote sensing systems and data to first responders. GOMI worked with state agencies and NASA flight crews to coordinate in situ sampling programs with satellite and aircraft flights, and SSC served as the agency's point of contact for the spill response. SSC also conducted joint projects with the University of Southern Mississippi and Datastar, Inc., to survey the Mississippi barrier islands for oil contamination and assess the impact of that contamination. SSC collected oil spill samples and provided them to other NASA centers to evaluate NASA spinoff technologies for oil spill remediation.

In 2011, GOMI will help monitor the health of the Gulf as it recovers from the oil spill. For instance, GOMI's work in coastal marsh monitoring and regional sediment management will provide key milestones for tracking the environmental health of the region.

Remote Sensing Training

The Applied Sciences Program conducts professional-level training focused on building skills in the access and use of Earth observation data. In 2010, the training program conducted six sessions and workshops on remote sensing and Earth observations in the United States and Canada for nearly 100 end users. The training sessions are designed to be hands-on, computer based trainings to support users' awareness, access and use of the Earth observations.

Several key activities this year targeted state regulatory communities across the country. For the first time, Applied Sciences conducted training at a state regulatory agency – the California Air Resources Board (CARB). Attendees at this session included technical staff and modelers focused on aerosol and trace gas products for fire and industrial pollution applications in California. At the end of 2010, CARB was utilizing *Aura* OMI NO_2 imagery for air quality management activities.

In June, the program held a five-day training workshop at the University of Maryland, Baltimore County. This event hosted 40 attendees from academia and government, including regulatory agency staff from Virginia, North Carolina, Maryland, Delaware and Washington, D.C. The workshop began with three days of basic training on Earth observations and remote sensing concepts. The final two days had separate tracks – one designed for academic users and one for regulatory agency personnel. Invited speakers from the EPA, Maryland and Virginia provided briefings on successful applications of NASA Earth observations from a regulatory agency perspective.

In October, the Community Modeling and Analysis System at the University of North Carolina hosted a training workshop for modelers. Applied Sciences designed the training on case studies for enabling comparisons between NASA imagery and regional air quality forecast models.

Applied Sciences conducted training sessions in Calgary and Montreal, Canada, in conjunction with the 2010 Air & Waste Management Association (A&WMA) Annual Meeting and the Canadian A&WMA chapter.

In 2010, the training program formed a working group of people from both the applied end-user and applied research communities. The group will help incorporate end-user needs and applied research into future NASA training materials and workshops.

In 2010, the program initiated development on remote sensing training modules and case studies for water resources applications. The initial modules and case studies focused on *TRMM* precipitation products and web tools.

Applied Sciences will continue training activities with end users in 2011. Planned events include workshops on air quality applications with additional state and federal agencies. Future workshops will address water resource management and disasters with primary topics focused on extreme weather events, such as flood and drought monitoring. Workshops will also address snow melt issues impacting the Central and Western United States. The program will initiate pre- and post-workshop evaluation surveys to better understand training benefits for management activities and to improve future training sessions. ●

Group on Earth Observations

The Applied Sciences Program continues to play a key role in GEO activities by participating in committees, leading tasks and initiatives, and supporting GEO communities of practice.

GEO is a partnership of 86 nations and the European Commission. In addition 61 intergovernmental, international, and regional organizations with a mandate on Earth observations or related issues are active as participating organizations. GEO is coordinating efforts to establish the Global Earth Observation System of Systems (GEOSS), which builds on national, regional and international observation systems and data from thousands of instruments.

Earth Observations Priorities: GEO Task US-09-01a

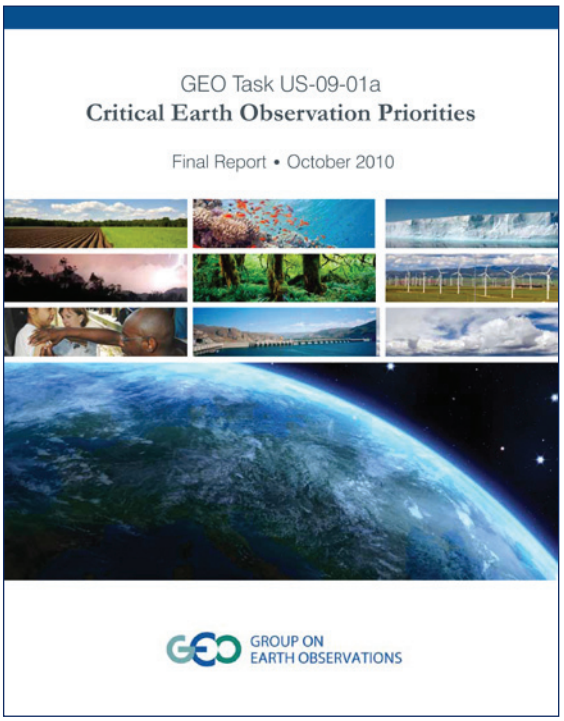
In 2010, a GEO Task Team led by the NASA Applied Sciences Program delivered results of a four-year study on Earth observing needs common to a range of users. The task, known as GEO Task US-09-01a, identified users' observation needs and ranked key Earth observations that provide critical benefits to society. The study focused on the "demand side" of Earth observation needs, concentrating on commonly-needed observations regardless of current availability.

The Task Team delivered individual reports for the priority observations for each of the GEO Societal Benefit Areas (SBA). More importantly, the Task Team delivered a cross-cutting report on the priority observations common to many of the SBAs. The Task Team identified 146 priority observations, and it used an ensemble of methods to rank and determine common observations.

Precipitation, soil moisture, and surface air temperature were the three highest-ranking priority observations. The top 18 observations were common to five or more SBAs, with 50 observations common to three or more SBAs.

The set of priority observations provide a starting point for planning activities for GEO and other organizations. The findings support efforts to determine investment opportunities that best meet the common needs of end users, while also providing a baseline for further engagement with users. Moving ahead, the set of priorities enable an assessment of current and planned availability of the observations, so GEO can communicate gaps and opportunities for increased societal benefits.

Further information on GEO Task US-09-01a is available at *http://sbageotask.larc.nasa.gov/*



To access more information on GEO, use this QR code with your camera-enabled smart phone or visit the website below.

http://www.earthobservations.org

GEO Global Agricultural Monitoring

The Program continues supporting the efforts of GEO's Global Agricultural Monitoring (GLAM) initiative to improve agricultural management and food security monitoring.

In 2010, GLAM successfully developed a customized global crop monitoring system using MODIS Earth observation data. The system significantly enhances the USDA Foreign Agriculture Service (FAS) global crop production analysis by reducing data delivery time from 4-10 days to less than 24 hours. The MODIS data is instrumental to FAS crop analysts responsible for generating timely crop production estimates that monitor worldwide food supply and crop price volatility. The project is a collaboration of NASA, USDA FAS, UMD, and South Dakota State University.

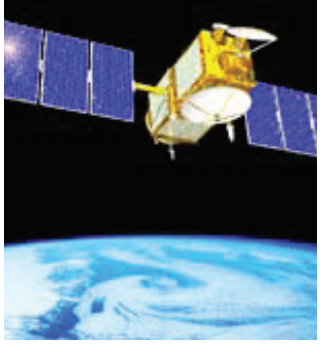
Along with UMD, the Applied Sciences Program continues to support GLAM's efforts to develop and build aspects of GEOSS for agricultural monitoring. GEOSS supports integration within the international agricultural monitoring community and provides decision support tools to a wide range of users via the Internet.

GLAM also initiated a Joint Experiment on Crop Assessment and Monitoring (JECAM) by identifying international pilot sites in 2010. Pilot sites include areas in the United States, Canada, Mexico, Belgium, and China. JECAM's goal is to facilitate the comparison of monitoring and modeling methods to identify best practices for agriculture monitoring. Activities at the sites address satellite and in situ data acquisition requirements and assess common data standards and cropland modeling methods. Three sites were in the operational pilot phase, with teams developing soil moisture monitoring and cropland modeling methods. Other sites were in the research phase. For more information on JECAM and individual country sites, visit: *http://www.umanitoba.ca/outreach/aesb-jecam/.*

GEO Biodiversity Observation Network

Applied Sciences continues leading ESD contributions to the development of the GEO Biodiversity Observation Network (GEO BON). GEO BON is a global "network of networks" to integrate information from multiple sources to understand the status of and track changes in the world's biodiversity. The network supports the analysis of changes in biodiversity to aid decision makers to set policy for improved conservation and natural resource management. ESD is a major sponsor and organizer of GEO BON, with the Applied Sciences' Ecological Forecasting Applications area leading the efforts.

In 2010, Applied Sciences organized and led a February workshop of the GEO BON Topical Working Groups, delivering a report on eliminating technical barriers to accessing data and integrating across sectors. In May, GEO BON delivered its Implementation Plan, as planned. In November, the GEO Ministerial Summit highlighted the work of GEO BON as a success. ●



Applied Sciences Program Management

This section provides information on major changes the Program initiated in 2010, especially to its focus and performance measures. In addition, this section describes workshops the Program organized throughout the year.

This section also describes the significant efforts made to increase involvement of the applications community in early-stage planning activities for future Earth-observing satellite missions.

Overview of Program Changes in 2010

2010 was a noteworthy year for the Applied Sciences Program. The Program made significant changes to its structure and priorities to better focus its efforts.

The Program refined its approach to selecting new projects, developed a new method to track project performance, and introduced activities to involve the applications community in satellite mission planning. This section summarizes the major changes.

Setting Priorities

Before 2010, the Program had aligned its applications themes with the nine areas of the US Group on Earth Observations – Agriculture, Climate, Disasters, Ecological Forecasting, Energy, Health, Oceans, Water and Weather.

In 2010, based on an analysis of financial and personnel resources, the Program concluded that it could not pursue all nine effectively. The Program made a difficult decision to emphasize only a sub-set of these. In setting priorities, the Program drew especially on information from the National Research Council's report *Earth Science and Applications from Space*.

The Program selected four Applications areas to emphasize: Water Resources, Health (including Air Quality), Ecological Forecasting, and Disasters.

This emphasis on a subset means that there are important applications that may not be pursued, and there are societal benefits that will not be realized. Thus, it is the full hope of the Program to have nine, thriving Applications areas at some point in the future. The Program will seek opportunities to resume and grow into the remaining five as resources allow.

Refining Project Selections

The Program assessed its method for selecting projects and developed a new, two-stage approach. In 2011, the Program will begin using this new approach as a way to identify more high-reward projects. Initially, the Program will sponsor numerous short-term feasibility studies to test applications ideas and assess their potential value. Then, the Program will select a sub-set of successful studies to pursue in the long-term, with partner funding and commitment as key factors in the selection. This approach can generate numerous applications ideas and focus investments on those with high-reward potential.

New Applications Index

As part of a new set of performance measures, the Program introduced a nine-stage Applications Readiness Level index to track the maturity and progress of projects from idea through sustained use.

Additional Activities

The following sections discuss additional activities that Applied Sciences conducted in 2010 related to management of the Program and support of the applications community. The sections discuss activities to overhaul the Program's performance measures and workshops to increase end-user engagement with planning for upcoming satellite missions. The sections also provide information on activities for documenting and quantifying the socioeconomic benefits derived from applications of Earth observations. ●

The Applied Sciences Program developed a nine-stage Applications Readiness Level (ARL) index in 2010.

The index is an adaptation of the Technology Readiness Level (TRL) scale used at NASA to assess technical maturity in sensors and hardware development. The ARL index provides a systematic, graduated scale to assess and track the maturity of applications projects – from the initial idea, through its stages of development, to its transition to operational use.

The ARL allows Applications area program managers to articulate the expected maturation for an applications project and to assess the actual progress of a project. Project teams can use the ARL to establish and articulate key project milestones. The index serves as a communication tool for program managers and project teams to track and discuss a project.

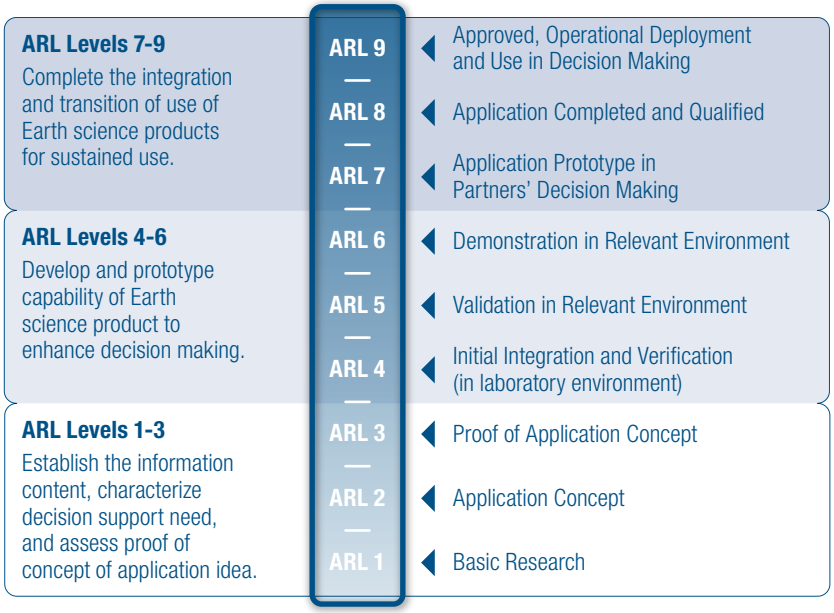
The Program plans to use data on projects' ARL progressions to conduct analyses and assess the difficulty of discrete stages in application development efforts. These analyses will help identify factors that inhibit progress. The Program can devote additional attention to especially difficult stages and design interventions to increase the likelihood of successful projects.

In 2011, the Program will assess current ARL levels for existing projects, and will begin including ARLs in solicitations for new projects. In 2012, the Program will begin using an ARL-based performance measure in its Annual Performance Goals. Eventually, the Program will use the ARL to assess the performance of individual projects, project portfolios of each Applications area, and the Program overall.

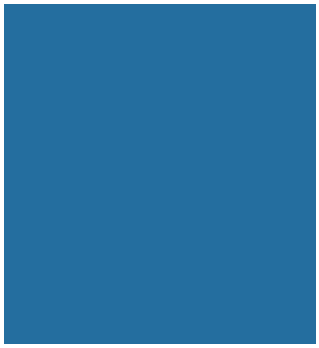
Vignette: Example of ARL in Use

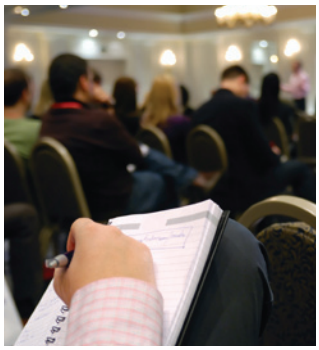
In the energy sector, electricity demand is referred to as the "load." Utility companies use load forecasts to anticipate energy demands and to plan for purchase of gas and electricity, gas storage, and electricity production. One Applied Sciences project, led by Battelle, aims to apply Earth observations to improve the accuracy of load forecast models. More accurate load forecasts can help utility companies meet demand more efficiently and save utilities and consumers energy and money.

The project began in 2008 at ARL 2. In 2010, the project completed its historical analysis and began operational testing, reaching ARL 5 at the end of the year. In 2011, the project will begin its detailed statistical analysis and demonstrations in utility planning decisions. With delivery of tools and documentation to support the transition of the application, the project plans to conclude in 2012 at an expected ARL 7. Reaching higher ARL levels will depend on final project results, which will affect adoption of the application by utility companies and weather forecast providers. ●



Performance Measures





In 2010, the Applied Sciences Program surpassed its annual performance goal and completed an effort to review and improve its overall performance measures.

Annual Performance Goal

Applied Sciences exceeded the FY2010 Annual Performance Goal that NASA reported to the Office of Management and Budget. The Program delivered 18 reports describing how the use of NASA Earth observations data improves partners' decision-making activities, which was 50 percent more than the FY2010 target. The reports are available on the Applied Sciences' website at *http://appliedsciences.nasa.gov/HighlightsAndResults-PG2010.php*.

New Performance Measures

A major activity in 2010 focused on revamping the Program's performance measures. The Program developed a comprehensive and balanced set of performance measures to assess progress in its projects and delivery on Program goals. To identify key measures, this development effort focused on programmatic outcomes and key performance drivers that result in successful transitions and the increased, sustained use of Earth observations in decision making. The revised performance measures will support assessments and stewardship of individual projects and the Program.

The performance measures are largely based on the Applications Readiness Level index, which the Program developed in 2010. The Program will use the ARL index to assess the progress and maturity of individual projects, portfolios of projects, and the performance of the Program overall. The Program will begin implementing the suite of performance measures by incorporating items such as ARL levels into proposal solicitations, project reviews, and project reporting.

Impact Analyses

In 2010, the Program began pilot efforts to analyze and substantiate the socioeconomic benefits of projects applying Earth observations in decision making. Over time, the Program plans to conduct such analyses across applications themes, analytic methodologies, and types of decision making. These efforts will build capacity of the Earth science community on techniques to determine and quantify the socioeconomic benefits of Earth observations. The Program sponsored a workshop in 2010 to initiate the pilot efforts.

Future Performance Goals

The Program's FY2011 Annual Performance Goal calls for the completion of socioeconomic impact analyses of two projects that apply Earth observations to support decision-making activities.

The FY2012 Annual Performance Goal is for 25 percent of the Applied Sciences Program's decision-support projects to advance at least one level in the Applications Readiness Level index. ●

Quantifying Socioeconomic Benefits of Earth Observations

In June, the Program sponsored a workshop to begin building capacity for substantiating and quantifying socioeconomic benefits from the use of Earth observations.

This workshop, "Value of Information: Methodological Frontiers and New Applications," was the first of its kind to examine and explore analytic techniques for calculating the value of Earth science information in decision making. The two-day session brought together a diverse group of 120 attendees from across public and private sectors, including leaders from environmental sciences, public health, and the physical sciences.

The workshop introduced attendees from the Earth science community to the principles, lexicon, approaches, and academic rigor of economists and social scientists. Sessions highlighted numerous opportunities and generated ideas for areas of future collaboration among attendees. Attendees expressed an interest in establishing one or more working groups to standardize language, approach, and visualization of value of information studies. Attendees also suggested convening groups of physical and social scientists to jointly design and evaluate impact studies on major Earth sciences projects.

Workshop discussions focused on the meaning of "value" and state-of-the-art methods used to ascribe value to information. The sessions focused on five discrete approaches at the frontier of methodological advances: price- and cost-based derivation; Bayesian belief networks; regulatory cost-effectiveness; econometric modeling and estimation; and simulation modeling and estimation.

Resources for the Future (RFF) and RFF's Center for Disease Dynamics, Economics & Policy organized and hosted the workshop, and they authored the final workshop report. RFF established a document library with more than 50 documents, including peer-reviewed, published articles and reports.

This workshop also sparked collaboration between NASA and the European space community, which may lead to a series of workshops on activities to further substantiate and quantify socioeconomics benefits from Earth observations.

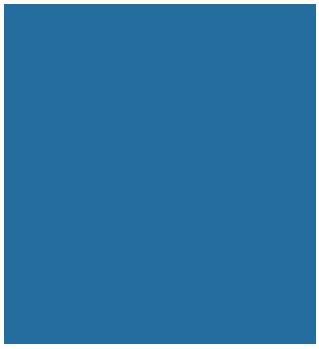
To demonstrate the application of some of the methodologies and to help develop capability in the field, the Applied Sciences Program began funding a series of pilot socioeconomic impact analyses on recent applications projects, and it is developing a guide to socioeconomic impact analysis for Earth scientists.

In 2011, the workshop organizers plan to publish the papers presented at the workshop in a volume on value of information research and applications. There are also plans for additional workshops to continue bridging the gap among the Earth science, social science, economics, and decision science communities and addressing the needs for applying methodologies to evaluate socioeconomic benefits of Earth observations.

Through workshops, pilot analyses, and other opportunities, the Program will continue to provide leadership in identifying techniques and building capacity in the community to quantify benefits of the applied use of data from the nation's important investments in Earth science and observations.

To access the workshop summary, visit: *http://www.rff.org/RFF/Documents/rff-confsum-info-aug10.pdf*. ●

Engaging Users in Satellite Mission Planning



In 2010, the Applied Sciences Program increased emphasis on communication with the applications community about involvement in Earth science satellite missions.

The Program, with other ESD Programs, sponsored multiple events to encourage active participation in early stages of the mission planning lifecycle.

The workshops involved different audiences, from broad cross-sections of users to specific groups. The sessions provided information on upcoming missions and the mission planning activities that NASA follows. Overall, the workshops sought to educate the applications community and potential users about NASA Earth science satellites and ways to contribute to mission planning and data product development. The sessions also sought to encourage the attendees to envision new applications and anticipate the availability of new Earth observations and data products.

NASA Earth Observing Missions Applications Workshop

February 1-3; Colorado Springs, CO

The Program sponsored a workshop together with ESD's Flight Program and Earth Science Technology Office to engage a broad cross-section of the applications community in the mission design process. Attendees included 132 participants from academia, NGOs, federal and state governments, Earth observing mission representatives, user communities, and NASA data centers. Sessions examined lessons learned from previous Earth observing missions and discussed mission planning phases and key challenges to achieving application goals. The workshop discussed key issues for applications communities, such as data continuity, latency, and infrastructure improvements needed for accessing high-level data products and providing rapid access to data.

Attendees also discussed the necessity for yearly user meetings and routine interaction with user groups and agency partners to keep the community engaged during the early stages of mission planning. Attendees suggested the development of roles and responsibilities to provide structure for users and other agencies wanting to support mission planning.

Participants focused on addressing strategic priorities, organizational issues, and data needs. For example, key recommendations were to organize applications around grand societal challenges that cross-cut the diverse needs of the applications community and to integrate applications users into early stages of mission planning so applications are part of the scope of the mission design. They also recommended that end-user adoption of mission data in applications and its use on a long-term basis should be part of the metrics for success of the missions and the value of the data.

Workshop materials and final recommendations are available online at *http://appliedsciences.nasa.gov/2010EOMA-Workshop.php*

Earth Observing Satellites & Conservation NGO User Group Workshop

November 10; Washington, DC

The Program sponsored a specific workshop with the conservation community. This event was a direct outcome of a recommendation from the broad community workshop in February 2010.

This workshop, "Earth Observing Satellites & Conservation NGO User Group," convened end users focused on conservation efforts. Conservation International, the World Resources Institute, and the Applied Sciences Program co-hosted the event for 29 people from 10 NGOs supporting international conservation efforts. The workshop provided information on mission planning and sought to spur the early involvement of the conservation community in the satellite mission lifecycle.

This one-day workshop focused on potential applications of NASA's eight most conservation-relevant Earth observing missions scheduled for launch between 2011 and 2025. The missions included the *Geo-CAPE*, *HyspIRI*, *GPM*, *SMAP*, *LDCM*, *DESDynI*, *ICESat-2* and *NPP* satellites. NASA scientists and program managers presented information about each mission and answered questions from the attendees.

Additionally, the workshop identified application needs of the conservation community. The attendees discussed ways to engage conservation specialists and other end users earlier in the mission planning lifecycle. Finally, the workshop provided a forum for exploring technical challenges conservation users face when working with Earth observing satellite data.

Key technical concerns of participants focused on data issues, including increasing data accessibility and issues of data continuity. Participants also generated recommendations on strategies the conservation community should take to enhance their understanding of and engagement in Earth observing mission planning and applications development. These ideas focused on ways to continue engaging groups within the NGO community, including webinars, additional workshops, and cultivating proposal ideas from across the conservation community.

Georeferencing, Geometric Accuracy, and Visualization of NASA Mission Data Forum

November 18; Orlando, FL

The Applied Sciences Program, in conjunction with the ESD Flight and Earth Science Data Systems Programs, held a forum at the American Society for Photogrammetry and Remote Sensing (ASPRS) 2010 speciality conference on Geospatial Data and Geovisualization. The NASA-sponsored event specifically focused on meeting with remote sensing and applications specialists to review data issues and discuss future needs for data products and applications for integration into future mission planning. More than 50 government and private-sector attendees participated in the session, with most participants working in geospatial analysis and aerial imagery.

Feedback from attendees focused on how NASA Earth observations can be more effectively used by the ASPRS community. Improving higher-level data products and increasing the ease of integration into decision support systems were key issues among these users. Data accuracy and data visualization were other important issues, particularly when developing mapping and Geographic Information System (GIS) products. Other areas of improvement included increasing data timeliness and addressing gaps between data distribution and the end-user community. Information gathered in the session will improve the design of data systems and data products developed from future satellite missions. In 2011, a report on key findings and recommendations from the workshop will be available on the Applied Sciences website.

Looking Ahead to 2011

We are enthusiastic about opportunities that lie ahead in 2011. As a new year begins, we look to complete several projects, fully implement the programmatic changes, and begin new applications projects that continue demonstrating the value of Earth observations.

New Solicitations and Awards

In 2011, the Program will issue numerous solicitations for new projects. We will issue solicitations using the new two-stage approach to project selection, including calls for proposals in the Water Resources and Disasters Applications areas. We will also introduce interdisciplinary applications solicitations, focusing on topics that cut across several Applications areas. The first of this new cross-cutting solicitation type will address wildfires.

We will select and commence an Air Quality Applied Sciences Team. This team of more than a dozen experts will pursue key applied research topics of importance to the air quality management community. Members will form ad hoc teams to address short-term needs identified by state governments and air quality agencies. This team will be a vital resource to air quality managers across the country as the team communicates and applies the latest scientific knowledge.

In 2011, we will solicit for a SERVIR Applied Sciences Team. We will also support applications specialists to be members of science teams for missions such as *Aura*, *NPP*, and *ICESat-2*.

Review of Satellites' Utility

The Program will support NASA's biennial review of Earth science satellites that are past their prime operating phase. This Earth Science Senior Review will evaluate 12 NASA satellites. The Program will organize the review's National Interests Panel to assess the utility of the satellites for non-research purposes by public and private organizations. This information will be combined with scientific value, costs, and technical issues for each mission in determining which satellites will continue to operate.

Attention to Disasters Applications

The past year included numerous, high-profile natural and technological disasters. These events highlighted the value that Earth observations can contribute to disaster response and illustrated potential opportunities for research into disaster processes, warnings, or mitigation. These activities demonstrated the need for an organized effort for disaster response. In the coming year, we plan to hire a full-time Disasters Program Manager to lead our Disaster Applications investments and direct the Earth Science Division's disaster response. We expect to develop a formal plan for the Division's disaster response activities, which can move the Division from its current ad hoc approach to one of coordinated planning and preparation.

Building Capacity

2011 will likely be a big year for DEVELOP. We expect that 2011 will be a record year for DEVELOP applicants, internships, and projects. We plan to begin efforts to identify new DEVELOP nodes for greater national breadth, and the program plans to add a National Science Advisor.

We will continue efforts to build capabilities in determining and quantifying socioeconomic benefits of Earth observations and their use in decision making. We also look forward to increasing efforts that enable the applications community to support Earth science satellite mission planning. We will identify Headquarters program managers and Center representatives as applications leads for respective satellite missions.

We are excited about the new opportunities and new responsibilities that await the Program in 2011. We expect that the decision to focus on a sub-set of applications themes will allow us to reach greater depth and richness of success in each theme.

You can follow our progress and learn more about the Applied Sciences Program at *http://AppliedSciences.NASA.gov*.

Have you thought about how to apply Earth observations in your organization? ●

List of Acronyms

A&WMA: Air & Waste Management Association

ALOS: Advanced Land Observing Satellite

AMSR-E: Advanced Microwave Scanning Radiometer - Earth Observing System

ARC: Ames Research Center

ARL: Applications Readiness Levels

ASTER: Advanced Spaceborne Thermal Emission and Reflection Radiometer

AVHRR: Advanced Very High Resolution Radiometer

BAAQMD: Bay Area Air Quality Management District

CAFTA-DR: Dominican Republic-Central America-U.S. Free Trade Agreement

CALIPSO: Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation

CARB: California Air Resources Board

CDC: Centers for Disease Control

CEOS: Committee on Earth Observation Satellites

CI: Conservation International

CIMSS: Cooperative Institute for Meteorological Satellite Studies

CMVSRP: California Mosquito-borne Virus Surveillance and Response Plan

DESDynI: Deformation, Ecosystem Structure and Dynamics of Ice

DoD: Department of Defense

DoE: Department of Energy

DoS: Department of State

EAGLES: Ecosystem Assessment Geospatial Analysis & Landscape Evaluation System

Envisat: European Space Agency's Environmental Satellite

EPA: Environmental Protection Agency

EPHTN: Environmental Public Health Tracking Network

ERS-2: European Remote Sensing Satellite-2

ESA: European Space Agency

ESD: Earth Science Division

FIA: Forest Inventory and Analysis

FIRMS: Fire Information for Resource Management System

FWS: U.S. Fish and Wildlife Service

GEO: Group on Earth Observations

GEO BON: GEO Biodiversity Observation Network

GEO GLAM: GEO Global Agricultural Monitoring

GEOSS: Global Earth Observation System of Systems

GFIMS: Global Fire Information Management System

GIS: Geographic Information System

GLAM: Global Agricultural Monitoring

GSFC: Goddard Space Flight Center

GOMI: Gulf of Mexico Initiative

GRACE: Gravity Recovery and Climate Experiment

HyspIRI: Hyperspectral Infrared Imager

I&M: Inventory and Monitoring

ICESat: Ice, Cloud and land Elevation Satellite

ICIMOD: International Centre for Integrated Mountain Development

IEA: International Energy Agency

JPL: Jet Propulsion Laboratory

LaRC: Langley Research Center

MERRA: Modern Era Retrospective-analysis for Research and Applications

MISR: Multi-angle Imaging SpectroRadiometer

MODIS: Moderate Resolution Imaging SpectroRadiometer

MSFC: Marshall Space Flight Center

MSG: Meteosat Second Generation

NASA: National Aeronautics and Space Administration

NASS: National Agricultural Statistics Service

NCAR: National Center for Atmospheric Research

NCDCM: North Carolina Division of Coastal Management

NMFS: National Marine Fisheries Service

NOAA: National Oceanic and Atmospheric Administration

NOAA/STAR: NOAA Center for Satellite Applications and Research

NOAA/ERD: Emergency Response Division

NPP: NPOESS Preparatory Project

NPS: National Park Service

NRL: Naval Research Laboratory

ODF: Oregon Department of Forestry

OMI: Ozone Monitoring Instrument

OSTM: Ocean Surface Topography Mission (aka, *Jason-2*)

PaCOOS: Pacific Coast Ocean Observing System

PALMS: Park AnaLysis and Monitoring Support

PM: particulate matter

QR: Quick Response Code

RSIG: Remote Sensing Information Gateway

SAR: Synthetic Aperture Radar

SMAP: Soil Moisture Active and Passive

SMD: Science Mission Directorate

SSC: Stennis Space Center

3DAQS: Three-Dimensional Air Quality System

TOPS: Terrestrial Observation and Prediction System

UMD: University of Maryland

UN FAO: United Nations Food and Agriculture Organization

US GEO: US Group on Earth Observations

USAID: United States Agency for International Development

USBR: United States Bureau of Reclamation

USDA: United States Department of Agriculture

USFS: United States Forest Service

USGS: United States Geological Service

VAAC: Volcanic Ash Advisory Center

WAFS: World Area Forecast System

WHO: World Health Organization

WONDER: Wide-ranging Online Data for Epidemiologic Research

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